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CONTENTS:

	PAGE
The Electrical Resistance of Metals and Alloys at very Low Temperatures	491
Dr. Lodge on Symbols and Terms	492
Chloride of Lead Secondary Batteries	494
Some Interesting Peculiarities of the Alternating Arc Lamp (*illustrated*)	494
The Fusing Point of Copper Wires (*illustrated*)	497
A Coal Calorimeter	497
The Electrolysis of Common Salt	497
Alternators in Series and Parallel (*illustrated*)	498
Arc Lighting.—XI. (*illustrated*)	500
Correspondence:—Arc Lighting	503
Maximum Efficiency of Arc Lamps with Constant Watts	503
Electrical Education	503
Report of Tests of Epstein Accumulators	504
Two Successful Companies	504
Arrest of Mr. Harness and Dr. M'Cully	505
Legal:—Medical Battery Company	505
Notes	506
Contracts Open and Closed	509
Business Notices	510
City Notes:—West India and Panama Telegraph Company	511
Aluminium Company	511
Metropolitan Electric Supply Company	511
Traffic Receipts	511
Share List of Electrical Companies	512
Proceedings of Societies:—Physical Society	513
American Electro-Therapeutic Association (*continued*)	513
The Development and Transmission of Power from Central Stations.—VI.	515
New Patents	517
Abstracts of Published Specifications	517

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THE ELECTRICAL RESISTANCE OF METALS AND ALLOYS AT VERY LOW TEMPERATURES.

In the autumn of last year, Profs. Dewar and Fleming published a short account of an investigation of the electrical resistance of metals, non-metals, and alloys taken at the temperature produced by the evaporation of liquid oxygen when boiling under normal or under reduced pressures [*vide* ELECTRICAL REVIEW, Vol. xxxi., pp. 565-66]. The experiments described were of a preliminary character; but since then the investigation has been continued and extended, whilst more perfect appliances have been employed. Although the enquiry is still far from being complete, the results are of considerable interest as far as they have gone, and these form the subject of a communication to the *Philosophical Magazine* series [5], Vol. xxxvi., No. 220, pp. 271—300.

The general object of this research may be stated to be the determination of the specific electrical resistance of metals and alloys between the limits of temperature of about 200° C., and the lowest obtainable temperatures approaching the absolute zero. Special attention was directed to the examination of the variation of resistance with temperatures below − 100° C., and to the determination of the form of the temperature resistance curves as the temperature was reduced to the lowest points obtainable by the evaporation of liquid oxygen boiling under reduced or normal pressure. There were, therefore, two variables to be considered, viz., specific electrical resistance and temperature.

There are, as is known, two ways in which specific electrical resistance may be defined, viz.: (1) The volume specific resistance, and (2) the mass specific resistance. Of these the first was chosen as likely to introduce a smaller chance of error; consequently the mean cross-section of a series of very fine wires, prepared with great care from the metals and alloys under test, was determined, and from this value and that of the length, it became possible to state, when the resistance was known, the volume specific resistance of the material. The temperature changes in dimensions were not introduced, as the corrections would doubtless have been very small, and the results were finally stated in terms of the electrical resistance in electro-magnetic measure of 1 cubic centimetre of the material measured at 15° C., the said resistance being determined at the various temperatures to which the material is raised or lowered.

It was necessary to pay very special attention to the temperature measurements, and, since this was a matter of extreme delicacy, the method was selected of taking as a measure of temperature the change in electrical resistance of a wire of a standard material (pure annealed platinum), and defining temperature in terms of the change.

Such measurements can afterwards be translated into their equivalent temperatures on the absolute thermo-dynamic or air thermometer scales. Profs. Dewar and Fleming devote a considerable space in this article to the description and justification of the method adopted by them, quoting the investigations of H. L. Callendar, and Callendar and Griffiths [*Phil. Trans. Roy. Soc.*, Vol. clxxiii. (1887), A., pp. 161—230], on the practical measurement of temperature.

The materials chosen for experiment were *pure*; the term "*pure*" being a relative one, that is to say, the greatest possible purity was aimed at. Details are given of the methods adopted in preparing the metals and alloys, and in pressing or drawing them out into wires. Many of the metals were first obtained by electrolysis, since this means ensures, in the majority of cases, a greater freedom from foreign matters. The different wires had a diameter varying from ·08 mm. (3 mils.) to 0·25 mm. (10 mils.), and a length of from 1 to 3 metres. The diameters were measured by means of a micrometer-microscope, since they were too small for accurate callipering.

The resistance coils by which the resistance of the wires could be taken in a bath of liquid oxygen were specially devised. Stout high conductivity copper wire, 4 mm. in diameter, was cut into lengths, and pairs of these wires bent up and bound together at the middle, but insulated from each other with India-rubber tape. The ends were well tinned, and the bottom ends nicked. A very thin sheet of vulcanised fibre was then bound round the bottom ends of the copper rods, and sewn to them by silk thread. This formed a thin cylinder on which the wire to be tested was carried. A stout silk thread was then wound spiral fashion round the cylinder. The wire to be tested was next carefully wound on the fibre cylinder in between the silk thread, the several turns of which kept the turns of wire from becoming short-circuited. The dimensions of the cylinder varied from 2—3 cm. in diameter and 4—5 cm. in length. A number of such bobbins were prepared, and the wires wound on them were annealed by immersion in melted paraffin at 200° C. The resistance measurements were carried out by means of a Wheatstone's bridge, a Pitkin-Holden galvanometer of the suspended coil type, and one cell of a Hellesen dry battery, the usual connections being introduced.

Temperatures above zero C. were obtained by immersing the coils in a beaker of melted paraffin oil standing in a zinc water bath. Temperatures close to zero C. were chiefly obtained during the long frost in January, 1893, by placing the coils in paraffin oil in beakers which were placed in the zinc bath filled with broken ice. Temperatures down to — 78° C. were obtained by the use of carbonic acid "snow" and ether, or paraffin oil. By the employment of liquid ethylene — 100° C. could be reached. Liquid oxygen was then employed as the refrigerating agent to lower the temperature of the coils to about — 182° C.; and by producing a partial vacuum above the liquid oxygen still lower temperatures were approached.

Amongst the metals the following were experimented with: Platinum, gold, palladium, silver, copper, aluminium, iron, nickel, tin, magnesium, zinc, cadmium, lead, and thallium. Tables of results and charts of curves are given in the original paper, from which it appears that the order of conductivity of the metals at very low temperatures is different to their order at ordinary temperatures. At the lowest temperatures reached the best conductor is pure copper. The best conductors amongst the pure metals are those which are most sonorous; silver, aluminium, gold, and copper would make good bells, and are the best conductors; whilst lead, thallium, tin, and palladium, which are the worst conductors, would be unsuitable for this purpose. This is a very curious fact. An examination of the curve chart confirms the conclusion reached in the former paper, viz., that *the electrical specific resistance of all pure metals will probably vanish at the absolute zero of temperature.*

Similar tables and charts are given for alloys of platinum with silver, iridium, and rhodium, gold-silver, manganese-steel, nickel-steel, german-silver, platinoid, manganin, silverine, aluminium-silver, aluminium-copper, copper-aluminium, copper-nickel-aluminium, and titanium-aluminium.

It is expected that in a future communication the results of similar observations at still lower temperatures will be published.

DR. LODGE ON SYMBOLS AND TERMS.

DR. OLIVER LODGE, in a letter recently written to *Nature*, laments the insularity of the sciences, and regrets that those who attend the British Association meetings are obliged, more or less, to limit themselves to their own particular sections, and to the discussion of only such matters as lie in their own grooves. Some of the problems on which the biologist—especially, perhaps, the physiologist—is engaged are, or might easily become, of supreme interest to the physicist, notably everything connected with the sense organs, and similarly for other departments; hence it is to be deplored that a more inter-sectional system cannot be provided. As things are at present, Dr. Lodge fears that there may be so much drifting apart, that in time we shall cease to understand each other's language. The language of the physicists is mainly an adaptation of simple English phrases; it is full of common words, redefined, and made terse in connotation. They do indeed use the word "coefficient" occasionally, but there is a tendency to avoid it where possible; it came from the mathematicians. There are other long words, such as "Electricity" and its derivatives; these date from the Middle Ages; the more modern words are monosyllabic, or as nearly so as possible. Biology takes to itself words of highly dignified and elaborate structure, hendecasyllabic, or, at any rate, polysyllabic. They are extremely classical, and as unlike the language of daily life as can be contrived; they are chosen, however, with a view to accuracy. As an example of diversity in terms, Dr. Lodge observes that the biologists have been guilty of assigning a wrong sense to the word "energy." The term "energy" is a physical one, given to us by Thomas Young, and it has been fought for by the physicists through the greater part of the century; the biologist, instead of speaking of "specific energy," should use the words "normal activity" or "normal reaction." As a further example, microscopists have introduced the term "micron" for a thousandth of a millimetre; this might conveniently be

adopted by physicists. But everyone should agree to use it in the same sense. Many microscopists call it a "micro-millimetre," which it is not; and though they may mean the same thing, it can only be by an erroneous, because unconventional, use of the prefix "micro." Sometimes the word is written "micro" instead of "micron;" a very small divergence, but better avoided. A "micron" is a micrometre, or a milli-millimetre, or 10^{-4} centimetre" and a "millimicron" is a micro-millimetre, or 10^{-7} centim. Dr. Lodge protests against too much public use being made of the meaningless and wasteful symbols, μ, and $\mu\,\mu$, for these two lengths; they should never be allowed to obtrude into anything intended for the general reader, nor for workers in other departments of science. Electricians sometimes write 6ω when they mean 6 ohms; this is denounced as an evil precedent.

With all deference to Dr. Lodge, we are bound to confess that we do not agree with him in regarding the writing of ω for "ohms" as a "sin;" nor the writing of Ω for megohms, which we suppose he would condemn as a "*cosin*," or a peccadillo. In practical work—as, for instance, in the calculation of a score or two of cable tests—the time wasted in writing "ohms," "megohms," and "microfarads," might be worth many pounds, especially if the ship is waiting to make a final splice, with rough weather coming on. The symbol, ω, is a child of necessity, and a convention of highest value; and, although to avoid an algebraical meaning being put upon such symbols it is safer to write them as subscripts, 6_ω, than as 6ω or 6^ω, electricians will never agree to their extinction. On the plea of complexity, we submit that it is as unlikely for 6ω in a test-sheet to be interpreted as $6 \times \omega$, as that 60° F. should be read for $60^\circ \times$ F. in a table of temperatures, or 60 H.P. as $60 \times$ H. $\times$ P. in a treatise on the steam engine. The real point at issue is whether such terms are intended for specialists or the public. Our view is that they are for the specialists; the public must learn the conventions side by side with the thing expressed, and class them with such formulæ as: P.T.O., E.C., R.S.V.P., P.P.C., &c., which also might be *multiplied*, but uselessly.

Air Transformers.

THE mathematics of the transformer has always been a source of great attraction to some minds, as, in common with most alternate current questions, it offers a very tempting opportunity for the display of one's mathematical agility. Unfortunately, the transformer, as usually made, is a stiff-necked creature, and refuses to possess "constant coefficients of mutual and self-induction"; neither will it consent that $Ln = m^2$, consequently the authors of these papers have to treat of transformers whose induction takes place in a substance in which it is not a many valued function of the magnetomotive force. We have recently referred to Messrs. Crehore and Bedell's papers bearing on these and similar points; the latest utterance is in a paper by Mr. Rimington, read before the Physical Society. He treats of air transformers only, and arrives at the interesting result that the equivalent impedance does not necessarily diminish as the secondary current is increased, but in certain cases may increase with increase of secondary current; this may occur when there is magnetic leakage as well as in the usual orthodox case. In the case of ordinary transformers the frequency at which a similar effect might be expected to happen is very low indeed, and, consequently, the results have practical importance only from the instrument maker's point of view. The paper was accompanied by geometrical, or Blakesley methods of proof, the figures of which were of alarming complexity.

Transformer Testing.

THE only excuse for writing a description of methods of testing already published, is that the writer can collect together most of those relating to one subject, which are probably scattered through a variety of periodicals, and write a clear, concise, and accurate description of them, enabling anyone who wishes to do work in that subject to easily find the method most suitable for his use. This excuse can hardly apply to a set of articles on "Transformer Testing," by Henry M. Norris, the first instalment of which appears in our American contemporary the *Electrical World*. His diagrams are badly drawn and his descriptions very obscure, so much so that anyone not acquainted with the subject would probably misunderstand many of them. There are, moreover, several misprints, such as "log" for "lag," "dynamo" for "dynamometer." By the way, it is rather a pity that the latter word ever came into common use as applied to an instrument for measuring current, for though the force between a current in one coil and the same current in another is made use of, the instrument is primarily intended to measure current, not force. In describing the calorimeter method of measuring the losses in a transformer, Mr. Norris states "all radiation of heat must be prevented." If he is capable of accomplishing this he must be a peculiarly clever individual; all that ordinary mortals can do is to balance the heat lost by the heat gained from surrounding objects, which can be done by having the temperature of the entering fluid as much below that of the air as the temperature of the escaping fluid is above it.

The Action of Electricity upon Microbes.

WE gave in a recent issue of the ELECTRICAL REVIEW under the title of "Autoconduction," an account of Mons. D'Arsonval's experiments on the electrification of living bodies. The method adopted consisted in passing an electrical current of very high frequency through a solenoid within which was placed the subject to be operated upon. It is a rather long step from the genus *Homo* to the *Schizomycetes*, yet we learn that this scientist has now turned his attention to a study of the behaviour of bacteria in the solenoid. The unfortunate bacillus selected for experiment, rejoices under the name of *B. pyocyaneus*: its chosen habitat is the greenish blue pus which forms upon wounds under certain pathogenic conditions. The pigment which gives this colouration, is secreted during the life-processes of the bacillus; and it was observed that when tubes containing "cultures" of the microbe were placed within the solenoid the chromogenic power becomes affected the tint produced being paler. In these researches Mons. D'Arsonval has been assisted by Mons. Charrin, a well-known bacteriologist, and they offer the pregnant suggestion that since microbes affect the human economy, and they themselves can have their action conditioned by electricity, it is possible that the electrical state of the atmosphere may exercise some influence upon the spread or retardation of epidemic diseases. The subject is somewhat obscure, and crops of difficulties spring up as one begins to reflect upon it, but it is a field of research that might well receive attention. We confess, however, that we are by no means so carried away with the idea as to imagine that generalisations are imminent concerning "the spread, and it is to be hoped, the prevention of disease."

CHLORIDE OF LEAD SECONDARY BATTERIES.

BY EMILE ANDREOLI.

THE genesis, pedigree and history of the French, American, and English chloride of lead batteries is one of the most interesting tales of truth which a man may read in the literature of electricity. I will not, however, indulge in this description of the ups and downs of this invention of solid plates of peroxide of lead, and in reply to the criticism which appeared in your last issue, page 445, of the paper contributed to the *Journal* of the Franklin Institute by Mr. Herbert Lloyd, F.C.S., I will simply say a few words which, I hope, nobody will grudge me the right of saying, since I *was the first to make plates of chloride of lead, fused and cast on a lead or lead alloy grid*, and therefore the first to render useful and available, as positive electrode in a secondary battery, slabs of fused chloride of lead or other lead salts, cast and subsequently reduced and peroxided.

The great desideratum in a peroxide of lead plate is the *prise de courant, i.e.*, the system of canalisation or ramification which, on charging, distributes the current on all points of the peroxide of lead mass, and which, on discharging, collects it in the same manner, and sends it off at a steady rate. No grid, no current; no grid, no chloride of lead battery worth anything.

The construction of electrodes for secondary batteries by means of chloride of lead, or other lead salts, fused, cast, reduced and oxidised, although not quite as old as the hills, is old enough to allow me to say that there is nothing new in it; but so long as the fused lead salt was not combined with a metallic grid, the chloride of lead battery could not exist. There was not much merit in this idea of using a grid embedded in the active substance, still, there are people who made money out of it, although I opposed successfully, in this country, a certain specification for the use of a grid in combination with fused chloride of lead and which was not granted the Great Seal. "I do not feel justified in granting a patent for the said means. I therefore regard the invention of the applicant as having been patented by the opponent, and I refuse to seal a patent for the same."—*Extract from the Comptroller-General's decision.*

Although I am not interested in those French, American, and English chloride of lead storage battery companies, which work electrodes of metallised and peroxidised chloride of lead, in *combination with a grid*, I can give an opinion of their value as a man who knows the subject.

My experience is that a chloride of lead battery is equal, if not superior, to the batteries which have been used for several years, not only in England but elsewhere, and which generally consist of an agglomerate mass of oxides of lead, rendered solid by mechanical pressure, while fused and cast plates are naturally porous.

I also contend that its simplicity and quickness of formation compare with the best known batteries. I cannot go into the details of Mr. Lloyd's paper, I will confine myself to saying that the mode of manufacture of chloride of lead he describes, is neither the cheapest nor the best one. The casting of a mixture of chloride of lead and chloride of zinc is unnecessary.

It is a great mistake to believe that chloride of lead cannot be cast without breaking, unless mixed with chloride of zinc; and if chloride of zinc is used merely in order to render the plates more porous, there are other cheaper ways of doing it.

The formation of these electrodes takes place as rapidly as that of the ordinary plates.

I always found that the capacity of my plates was higher than 5 or 6 ampère hours, and that the rate at which the discharge took place was more than ½ ampère per lb.

Nothing is easier than to try the experiment and fuse and cast a few plates, which will be tested and compared to plates made by another process, and containing the same quantity of active material. I shall be surprised if the results given by the chloride of lead plates are not the best.

I do not intend to discuss the other points, such as the efficiency of the American battery, the use of asbestos cloth, &c. What can be more safely claimed for such electrodes as those which I have lately adopted, is that they hold more active substance imbedded in the cells of their two grids, riveted together at a convenient distance apart, and in contact between the two internal surfaces of the said grids and more conductive than any other electrode of secondary battery.

Mr. Lloyd's paper ends by these words: "A company has recently been formed in England for manufacturing these cells, which have just completed works near Manchester, capable of a very large output. That company is controlled by Messrs. Mather & Platt, probably one of the largest electrical engineers in Great Britain, and the business is to be managed by Dr. Hopkinson. Under such management there can be very little doubt about the success of the business."

When a process is good, and the patent granted for such a process is *good also* and unattackable, success is bound to come.

SOME INTERESTING PECULIARITIES OF THE ALTERNATING ARC LAMP.*

BY THOMAS SPENCER.

ALTHOUGH arc lighting by means of direct currents has been practised in this country for nearly 15 years, it is only quite recently that an attempt has been made here to utilise the alternating current for that purpose, although it is a historical fact that the very first attempts made to introduce arc lighting for street illumination were by means of such a current. I refer to the Jablochkoff candle. Jablochkoff found that he had to use an alternating current to make his two carbon pencils, which composed his candle, burn away equally. Since Jablochkoff's time there has been a great deal of work done in Europe, and especially in Germany, where greater progress has been made in the electrical sciences than in any other part of the eastern continent, towards utilising the alternating current for arc lighting, and I have the pleasure of showing you one of the latest productions of that country (both as to lamp and carbon to be used with it) this evening. The lamp itself, being an American production, is being manufactured by the Helios Electrical Company, of Philadelphia, under patents of the German Company of the same name. This lamp I will speak of later.

As I said before, it is only quite recently that alternating currents have been utilised for arc lighting. The first systematical attempt of the sort was, no doubt, that of the pioneers of alternating currents in this country, the Westinghouse Electrical Company, of Pittsburg, P.A., when they put upon the market their well-known alternating series system. This was, no doubt, brought about by a circumstance, and that circumstance was the invention by Mr. William Stanley, who was then consulting electrician for that company, of a wonderful constant current alternating current dynamo. This machine I look upon as one of the most beautiful in its performance of anything in the whole range of electro-dynamic machinery. It was my pleasure to be so situated as to have the handling of two of the first machines of this kind sent out by the company; the performances of these machines were simply wonderful. I have time and time again switched one of these machines from full load; that is, 60 arc lamps, each taking 45 volts, to a dead short circuit, with only a variation of half an ampère in the current, and this without any mechanical regulation. I would say, in passing, that with this machine the only thing to be feared was an open circuit, and that the safe way to run the machine was dead short circuited.

The principle on which this machine worked was very vaguely understood for some time, the inventor himself having a very complicated explanation, based on armature reaction, but no doubt the correct explanation is this: The machine has an armature of the tooth form, on which there is wound quite a large amount of wire, and as a result the electromotive force generated by the machine is quite large, but on account of the way the armature is constructed there is a large self-induction. These two factors being so great the actual resistance in the current becomes insensible in comparison with them, so the current is practically independent of the resistance in circuit; or, in other words, constant.

* Read at the meeting of the Electrical Section of the Franklin Institute, held June 27th, 1893.

This can more clearly be seen from the following equation :

Where

c, is the current.
E, the electromotive force.
R, the total resistance in the circuit, including the resistance of the arcs of the arc lamps.
L, the coefficient of self-induction.
$p = 2 \pi n$, where n is the frequency.

$$c = \frac{E}{\sqrt{R^2 + L^2 p^2}}.$$

Now, if E and L are very large in comparison to L R, we have

$$c = \frac{E}{L p}$$

or the current is constant, no matter what the external resistance may be, providing it is not too large.

With such a machine the Westinghouse Company thought they had solved the problem of arc lighting by means of alternating currents, but in this they were mistaken ; in fact, this was really the easiest end of the problem, and although this machine has now been known for over three years, this system has made little progress, due to the fact that these lamps did not come up to the standard set by the direct system in common use.

The fact is, that here in this country an alternating current arc lamp has been studied entirely on those lines on which a direct current lamp was found to give the best results, while European practice shows plainly that a treatment entirely different should be followed.

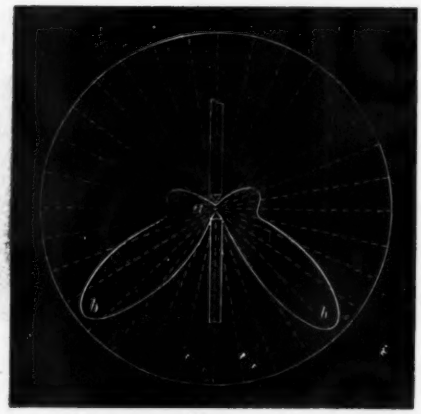


FIG. 1.

Let us study the arcs formed by the two kinds of currents ; first, as regards the distribution of their illuminating power.

Let fig. 1 represent the two carbon pencils in a direct

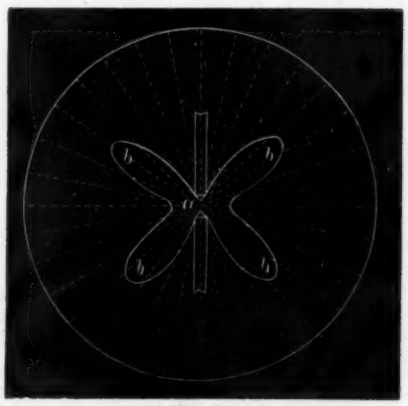


Fig. 2.

arc lamp, where the upper pencil is supposed to be positive. Suppose we take a, the arc, as a centre of a circle, and suppose we plot off on each radii the candle-power in the direction represented by it. Now, if we trace a curve through all the points thus found, we have a curve, as shown in fig. 1, from which we see that nearly all the light is thrown down in the direction a, b. This is due to the fact that nearly all the light from an arc lamp comes from the crater on the positive carbon.

Fig. 2 shows the curve for an alternating arc, which you see is altogether different from the first curve, there being four wings instead of two, as in the first curve, and these wings are shorter.

This distribution of light, of the alternating arc, has always been looked upon as a failing, for the light represented by the two upper wings is usually thrown up and wasted, especially if the lamp is out of doors. This defect has been in a great measure remedied in the lamp before you, by making the lamp focussing ; that is, making the arc remain always in the same place, and using a white reflecting plate close above the arc. This plate will reflect something like 80 per cent. of the light incidenced upon it. There is another point in which there is a great difference in the two currents, it is this : One of the first things noticed about the alternating current, was that there was very little arcing at switches where currents of large ampèrage were broken. This peculiarity was looked upon as a particularly valuable feature, for, in the construction switches, the arcing was the principal thing to be guarded against, especially where high voltages were to be broken. I think, with the general introduction of alternating current plants, this property is not appreciated. One has only to stand and watch the arc that follows a plug switch in a direct arc switchboard, where the voltage is not over 2,500 volts and 10 ampères, and to imagine what the result would be if the alternating current should suddenly acquire the same property, on some of the beautiful switchboards for incandescent lighting of about the same voltage and much larger ampèrage, when the switches began to be thrown. There has been a great many theories about this property of the alternating current, but it is about settled that it is due to the fact that at a certain instant there is no current flowing to keep up the temperature of the vapour through which the current is flowing, sufficient to maintain a strong, hardy arc, and as a result it is easily broken. Now, this property, although it is just the thing we want, as far as switches are concerned, is far from desirable when we come to use the alternating current for arc lighting. It is evident from what has been said that an alternating arc is much less hardy than that of a direct current, of the same current density. We see, therefore, that it is a mistake to follow the lines of the direct system in devising an alternating system. What is desired is to get as much heat generated as possible in the flame, so as to keep up the temperature of the vapour through the time when the generation of heat practically stops for the instant. This is best illustrated by fig. 3, where

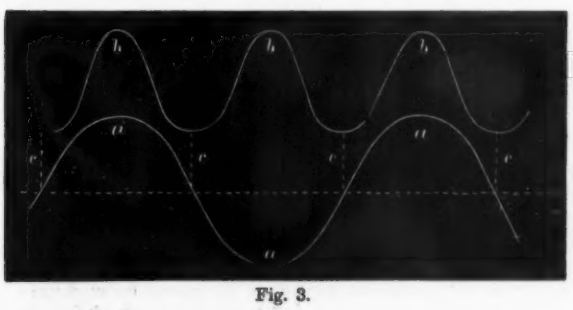


Fig. 3.

a, a, a, is the current curve, and b, b, b, the temperature curve of the flame for the same instants, and c, c, c, the minimum temperatures, which the flame reaches. Now, c, c, c, will be larger the larger the current, and the arc will be more hardy.

So it would seem that the only way to produce a good alternating arc lamp, is to use a large current, but a large current means a large candle-power, unless we lower what is called the counter electromotive force of the arc, or the drop in electromotive force which occurs at the crater itself. If we refer to fig. 4, where A and B are the carbon points, the distance between them being exaggerated for convenience, and suppose the drop in potential plotted from one point to the other, assuming A the positive carbon, we

find for the direct system, at the point, *a*, that is, at the crater, that there is a sudden drop of the potential to a point marked *b*. This drop is what is known as the counter electromotive force of the arc. For the remaining part of the distance the drop is more gradual, and varies as the current. This is the part due to the drop in the flame itself.

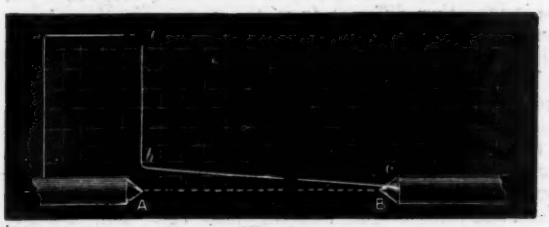


Fig. 4.

So it is apparent that if we could reduce the counter electromotive force, leaving as large a loss of energy in the flame as possible, we would get an arc which would be much less affected than with a smaller current, at the same time without any larger output in watts for the lamp. This has been done in the lamp before you by the use of a special low voltage carbon, which allows this lamp to give an illuminating effect with 28 volts and 10 ampères, equal to about that given by a 45-volt 7-ampère direct-current lamp. Referring again to the counter electromotive force, I would say that there has been a great deal of controversy over whether such a thing really existed. I myself am one of the party who believe in its existence. In fact, there is a strong current setting in the direction of that belief. I myself have been convinced that there was a real electromotive force in the arc by studying the alternating arc itself; in fact, there are reactions in the arc which could only be explained by the existence of a counter electromotive force. A gentleman in England, whose name I have forgotten, has recently tried an experiment of heating a carbon juncture in a hydroxygen flame, and was able by this carbon thermopile to get quite a difference of potential between the two carbons. He claims that his results were such as to account for the counter electromotive force of the carbons* had been raised to the temperature of the arc. Also, quite recently, Silvanus Thompson has tried quite a number of experiments bearing on this subject, and has come to the conclusion that the electromotive force is the result of the energy which disappears as latent heat in the volatilisation of the carbon in the crater.

There is another peculiarity of the alternating arc which is the most serious objection to it, from a commercial standpoint, and that is the noise made by the arc. Even this has been attacked, and so overcome that it is no longer the objection it was in the early forms of lamps using alternating currents. The cause of this noise is due to the constant variation of temperature of the flame, as I have described already, which produces an expansion and contraction in the surrounding air. The result is a musical note depending on the frequency of the current. That there is a real rise and fall, even in the light given out by the arc, can be shown by moving a white stick, or better, a short piece of white wire moved back and forth rapidly near the lamp, when the white band, caused by the preciseness of impression in the eye, will be observed to be broken up into bands, showing that the light is varying with the alternations.

The noise is, I find, a function of the form of the current curve. This came under my notice in trying to substitute a choking coil in place of a resistance to absorb the excess electromotive force above what was wanted in the arc. I noticed that the noise was considerably increased by the coil over the resistance. You can see that this is the case by the experiment I have arranged before you, which is so wired that either the resistance or coil can be used. You will observe that when the lamp is burning on the coil, there is considerable more noise than when the resistance is in circuit. The reason why this is the case will be explained by referring to fig. 5, where let *a*, *a*, *a*, be a simple curve of sines, which is very near the case, with a well-designed alternating dynamo. Let this curve be deformed by the current represented by it, passing through a choking coil with iron. The deformed curve will be something like the curve, *b*, *b*, *b*, due to the lack of constancy of the permeability, and to hysteresis in the iron. If we look at this curve we will notice an abrupt rise in it, which means a sudden rise of temperature in the flame; or in other words, we would have a sort of explosion, and as a result this form of current curve would be more noisy. There is no doubt but the form of the

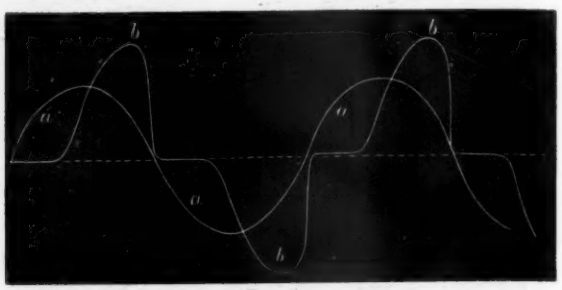


Fig. 5.

current curve, which would be the best as far as sound is concerned, is that of the simple sine curve, for in this curve the current rises gradually, and sinks away gradually.

One thing which puzzled me for some time was that I found that a choking coil, which contained no iron, even made more noise than when a resistance was used. As there was no changing permeability or hysteresis, in the arc, the cause for this increased noise was not quite so apparent. The explanation, no doubt, lies in the fact that no machine gives a true sine curve, but in most cases the curve is symmetrical as regards the rise and fall, as will be seen by the curve,

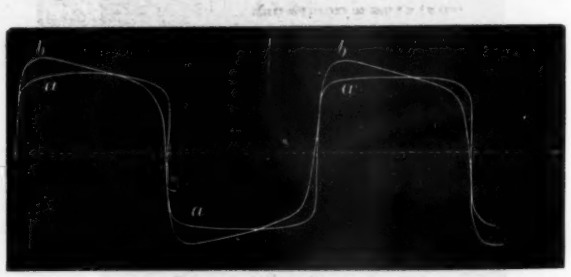


Fig. 6.

a, *a*, *a*, fig. 6, which is supposed to be the form of curve given by the dynamo. Now, a choking coil without iron would deform this curve to the form shown in the curve, *b*, *b*, *b*, on account of the change of phases which it would bring about in the different harmonies which make up the compound wave coming from the dynamo.

It is found that when the frequency is reduced the noise is greatly decreased; for instance, lamps burned by means of the current supplied by some dynamos recently turned out by the Westinghouse Electric Company, which have a frequency of 7,200, practically made no noise. On the other hand, Mr. Tesla, by going the other way, that is by raising the frequency above the audible point, made a perfectly quiet arc; but as high frequency introduced so many other objectionable features, I hardly expect to see this method very extensively introduced.

There is what you might call, still, a mechanical way by means of which the noise can, in a measure, be reduced, and that is by running with a short arc. The reason for this is self-evident, for by so doing you keep the flame well inside the hot walls of the carbon, which do not fluctuate as much in temperature as does the flame; as a consequence, the surrounding air is not so much affected, and the result, less noise.

I will say, in closing, that an alternating arc lamp is something very much to be desired, as it forms one of the links in a chain towards which all electrical engineering is now drifting. I refer to the designing of a central station, so that all kinds of electrical work can be done by one kind of current, which can be supplied by one kind of machinery, at the central station. Not as now by several different kinds, as I saw to-day, a station using at least five different kinds of dynamos. That the alternating current is to be the current settled upon no one will deny, on account of its great

* Apparently something has been omitted here in the original ext.—EDS. ELEC. REV.

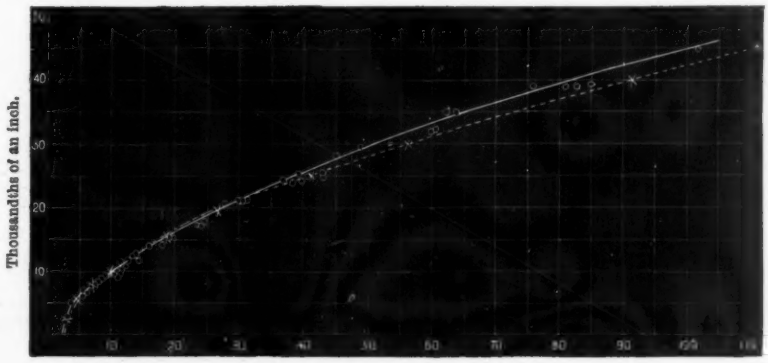
flexibility. Therefore, I believe the alternating arc lamp has a great future before it, even greater than the series arc has had in the past. It, therefore, gives me pleasure to exhibit to you to-night a lamp which I believe embodies in its construction the most advanced idea in alternating arc light engineering.

THE FUSING POINT OF COPPER WIRES.*

By J. C. LINCOLN.

THE accompanying cut shows a curve giving the relation between the fusing points and diameters of copper wire. The ordinates represent diameters in thousandths of an inch, and the abscissæ the corresponding fusing currents.

The readings were taken under the following conditions: The brass terminals in which the fuse was fastened were five inches apart between their nearest points, and weighed two ounces each; their shape was such that the wire was raised from three-fourths to one inch above the slate base. The room in which the experiments were made was guarded from draughts and had a temperature of about 80 degrees F. A Weston direct-reading ammeter was used in series with a rheostat and the fuse.



The points determined are plotted and the full curve drawn through their mean positions. A large number of readings was taken, giving a reliable character to the curve which, as will be seen, is a very fair one.

The curve was found to have approximately the equation, $x = \cdot 14\, y^{1\cdot 7} + 2\cdot 3$; the dotted curve is drawn to correspond exactly with this equation.

A COAL CALORIMETER.

MR. GEORGE H. BARRUS described his coal calorimeter in a a paper before the Engineering Congress at Chicago. The instrument has during the last three years tested nearly one hundred samples of coal of various types and from all localities. The instrument consists of a glass vessel 5 inches diameter and 9½ inches high, to hold the water required. Submerged in this is a bell glass, 2½ inches diameter and 4 inches high, with a long neck ¾ inch diameter, closed by a stopper. The upper end of the neck stands 5 inches above the top of the outer container. This inner vessel is the combustion chamber; it rests on a metal base to which it is held by a spring clip; this base is perforated and in its centre is a socket for a small crucible to contain the sample to be tested. It is made of platinum and insulated by non-conducting material from the metal cachet of the base.

There is a small glass tube in the stopper at the end of the combustion chamber neck which is carried down to the interior and loosely fitted so that it can be moved up and down to stand at any desired height above the crucible, and it can also be directed towards any part of the crucible. This tube carries in oxygen from a tank to burn the coal sample placed in the crucible, the pressure of the gas keeping the water back below the base. The products of combustion pass from the crucible through the perforations in the base piece, and thence bubble up through the water to the surface through an obstructing wire gauze.

In making a test there is used two kilogrammes of water and one gramme of coal. The instrument itself has an equivalent value of 185 milligrammes; one degree of rise of temperature of the water corresponds, therefore, with a total heat of combustion of 2,185 B.T.U.

Ordinary coal gives a rise of 5½° to 6½° Fahr., and the thermometer used is graduated to twentieths of a degree and by the eye to one-fifth this. The coal sample is dried and pulverised, and the initial temperature is observed when the whole instrument has become steady; the gas is turned on and the coal lighted by a small paper fuse. The initial temperature is fixed by means of cold or warm additions of water to secure that it shall be as much below the atmospheric temperature as the final is above it, thereby nullifying radiation and eliminating any need for insulation.

In a list of 42 tested coals, two are English—Lancashire and Welsh—and give 12,122 and 13,581, respectively, whereas some of the American coals gave considerably over 14,000, and but few gave so low a result as the Lancashire, or indeed, as the Welsh coal. This seems to show that the bad records of much American steam engineering—locomotive chiefly—is due to other causes than the oft asserted inferiority of the coal.

THE ELECTROLYSIS OF COMMON SALT.

[COMMUNICATED.]

FORMS of apparatus devised for effecting the electrolysis of common salt solution, and collecting the products set free about the electrodes, may be divided into two classes: Those having porous partitions between electrodes, and those without, but having some other device, chemical or mechanical, for collecting, or by which the products may be collected.

Of porous partitions, of course, there are a great many forms, but no practical data based upon their continued use appears to exist, and it will probably be some time before they are shown to be of much practical use for separating two such products as chlorine and sodium hydrate in solution, which is always above normal temperatures.

Of the method of employing mercury as the cathode, as a carrier of sodium from the electrolyte to another chamber containing water, in which the sodium is supposed to be given up and caustic soda formed, all that can at present be said with regard to it, in the absence of working data, is, that sodium requires a higher electromotive force than hydrogen to liberate, and therefore represents greater expen diture of fuel; that it is almost impossible, for the same

* New York *Electrical World*.

reason, to avoid the liberation of hydrogen, which, of course, forms an explosive mixture with chlorine ; that the circulation of the mercury and appliances incidental thereto means complication, and that impurities or foreign matter settling upon the surface of the mercury will be detrimental to its action. But it is a question whether mercury is practicable for employment in alkali manufacture.

The only form of apparatus of which at present there appears to be any hopes in practical circles, is that which has already gone through the ordeal of practical work at Snodland, Kent ; and from which only any electrolytic caustic soda in a solid form, and in bulk, has been produced and sold. It is simple, automatic, compact, all parts are easily and cheaply renewable, and no product is employed the loss of which can seriously affect the results.

The life of gas retort carbon as an anode in common salt solutions has been proved in this apparatus after night and day work for over a twelvemonth. Happily, it is much longer than was anticipated by the most sanguine, there being no difficulty whatever in constructing a cheap anode to last six months or longer.

The average efficiency of the apparatus on the basis of 210 ampère-hours to the pound of salt, is considerably over 80 per cent., maintainable until the solution attains 15 per cent. alkali, Na_2O, from which 70 per cent. is now being produced of excellent colour and purity, in the well-known commercial form, in drums ; manufacturers and others who have had it reporting upon it very favourably, as well as the bleaching powder produced.

The difference of potential at the terminals of the tanks, each having a capacity of 60 cubic feet, has been brought down by degrees to 4 volts, with a current of 500 ampères ; so that the energy consumption can be calculated therefrom and compared with other methods of manufacture. In round figures, one half of the voltage may be said to be employed in overcoming the counter electromotive force, from which the resistance proper of the tank is easily calculated.

A good margin of profit can be shown after deducting all costs and expenses incidental to a practical works, and nothing appears to stand in the way of the growth of this important new industry, which we hope may be the forerunner of others in the electrical world of a like progressive character.

ALTERNATORS IN SERIES AND PARALLEL.

BY ARTHUR WHITWELL, M.A.

IN the year 1884 Dr. John Hopkinson read a paper before the Institution of Electrical Engineers, in which, amongst other things he discussed the problem of the desirability of running alternators in series or parallel when independently driven. His use of the higher mathematics prevents many readers from following his reasoning as closely as could be wished, and I propose in the following article to discuss this problem in an elementary way, and to illustrate the reasoning by curves connecting the work done by each alternator with the difference of phase of the alternators. In the first case let two alternators driven independently be connected up in series and let the total resistance of the circuit be r, the total self-induction L, and the E.M.Fs. of the two alternators be $E_1 \sin p t$ and $E_2 \sin (p t + \theta)$, where $p = \frac{2\pi}{T}$, and θ = the difference of phase.

As only the total resistance and self-induction of the circuit enter into the question, particular values for the separate alternators need not be taken. The total impressed E.M.F. $= E_1 \sin p t + E_2 \sin (p t + \theta)$, or expanding and putting $\cos \theta = a$, $\sin \theta = b$

$$= (E_1 + a E_2) \sin p t + b E_2 \cos p t,$$

$$= \sqrt{(E_1 + a E_2)^2 + (b E_2)^2} \sin (p t + \omega),$$

where

$$\tan \omega = \frac{b E_2}{E_1 + a E_2}.$$

The total current may be obtained by the method described in the ELECTRICAL REVIEW of December 2nd, 1892, and

$$= \frac{\sqrt{(E_1 + a E_2)^2 + (b E_2)^2}}{\sqrt{r^2 + p^2 L^2}} \sin (p t + \omega - \phi),$$

where

$$\tan \phi = \frac{p L}{r}.$$

The watts or work per second of the lagging alternator (whose E.M.F. $= E_1 \sin p t$)

$$= \tfrac{1}{2} E_1 \times \frac{\sqrt{(E_1 + a E_2)^2 + (b E_2)^2}}{\sqrt{r^2 + p^2 L^2}} \times \cos (\omega - \phi),$$

E_1 and the fraction being the maximum values of the E.M.F. of the alternator and of the total current, and $(\omega - \phi)$ the difference of phase between these two. From the values of the tangents of ω and ϕ we find that

$$\cos (\omega - \phi) = \frac{r (E_1 + a E_2) + p L b E_2}{\sqrt{r^2 + p^2 L^2}\ \sqrt{(E_1 + a E_2)^2 + (b E_2)^2}}$$

Substituting this value, the watts of lagging alternator

$$= \tfrac{1}{2} \frac{r E_1^2 + E_1 E_2 (r a + b p L)}{r + p^2 L^2}.$$

The difference of phase between the E.M.F. of the leading alternator, and the total current is $\theta + \phi - \omega$ and $\cos (\theta + \phi - \omega)$

$$= \frac{(a r - b p L)(E_1 + a E_2) + (b r + a p L) b E_2}{\sqrt{r^2 + p^2 L^2}\ \sqrt{(E_1 + a E_2)^2 + (b E_2)^2}}$$

so that watts of leading alternator

$$= \tfrac{1}{2} \frac{r E_2^2 + E_1 E_2 (r a - b p L)}{r^2 + p^2 L^2}.$$

Putting $\cos \theta$ and $\sin \theta$ for a and b, watts of lagging alternator,

$$= \tfrac{1}{2} \frac{r E_1^2}{r^2 + p^2 L^2} + \tfrac{1}{2} \frac{E_1 E_2}{\sqrt{r^2 + p^2 L^2}} \cos (\theta - \phi),$$

watts of leading alternator

$$= \tfrac{1}{2} \frac{r E_2^2}{r^2 + p^2 L^2} + \tfrac{1}{2} \frac{E_1 E_2}{\sqrt{r^2 + p^2 L^2}} \cos (\theta + \phi).$$

In fig. 1 these results are plotted to scale, the ordinates representing watts or work per second, and the abscissæ difference of phase between the alternators or θ. For the particular case of fig. 1, $E_1 = E_2 = 100$ volts ; $r = 10$ ohms and $L = \cdot 02$ henries ; $p = \frac{2\pi}{T} = 500$; θ is the variable and $\phi = 45°$; $\tan \phi = 1$.

Curve A is that of the lagging, and B that of the leading alternator.

The equations reduce to

$$= 250 + 353{\cdot}5 \cos (\theta - 45°) \qquad (A)$$

$$= 250 + 353{\cdot}5 \cos (\theta + 45°) \qquad (B)$$

On examining the curves we find that for any difference of phase between 0 and π, the lagging alternator is doing more work than the other ; as the alternators are driven independently, the lagging one will, therefore, tend to slacken its speed and the leading one to quicken, consequently the difference of phase will increase until it becomes π. If the difference of phase is anything between π and 2π, it will be seen that the leading alternator is doing more work than the other, its speed will therefore slacken and the difference of phase will tend to become π. The points where the curves cross C and D (or E) are two points at which the alternators are doing the same work per second ; but whereas the point C is one of stable equilibrium, E or D is one of unstable equilibrium. If the phase difference is nearly 0 or 2π, it does not tend to become 0 or 2π, but it tends to become π. If the phase difference is a little more or less than π, it tends to become π. Hence, two equal alternators driven independently in series, settle down into opposite phases and do no work. In fig. 2, $E_1 = 100$ volts, $E_2 = 200$ volts, the other quantities remaining the same. The equations become

$$= 250 + 707{\cdot}1 \cos (\theta - 45°) \qquad (A)$$

$$= 1{,}000 + 707{\cdot}1 \cos (\theta + 45°) \qquad (B)$$

Reasoning in the same way as before, it will be found that of the two points, C, D, C is a point of stable and D of unstable equilibrium. By equating the right hand members of the two equations of work, we find that

$$\sin\theta = \frac{r}{p\,L} \quad . \quad \frac{E_2^2 - E_1^2}{2\,E_1\,E_2},$$

so long as $\frac{E_2^2 - E_1^2}{2\,E_1\,E_2}$ is less than $\frac{p\,L}{r}$ the curves cross in two points, one of stable and the other of unstable equilibrium, When these quantities are equal, one curve is tangent to the other at the point where the abscissa $= \frac{\pi}{2}$. When the first quantity is the greater, the curves do not meet and there is no point of stable equilibrium.

FIG. 1.

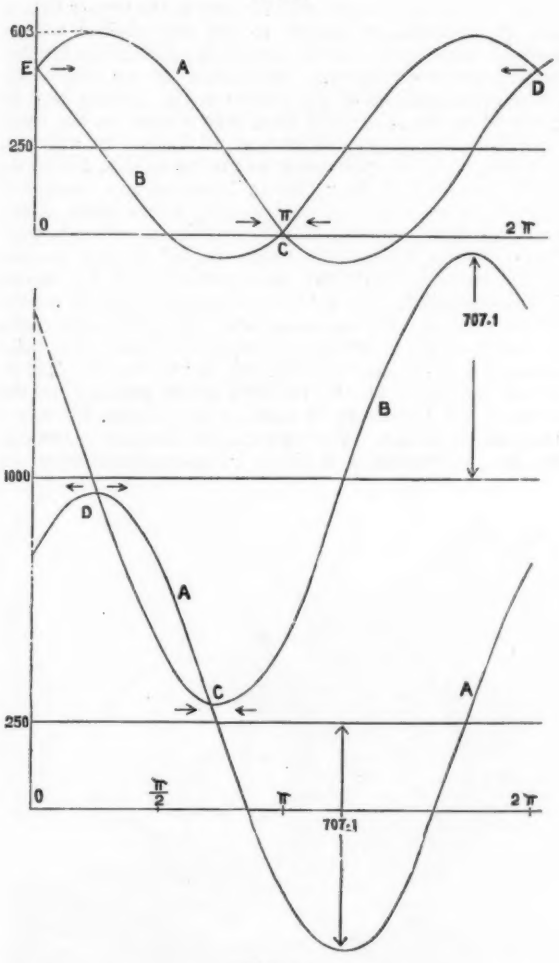


FIG. 2.

In the second place let the alternators be in parallel as in fig. 4, and let the resistance and self-induction of *each* alternator be r and L, the external resistance, R, and the E.M.Fs. be $E \sin p\,t$ and $E \sin (p\,t + \theta)$. The work which each alterator does per second $= \frac{1}{2} E\,C \cos\mu$, E and C being the maximum values of the E.M.F. of the alternator and the *current going through it*, and μ the difference of phase between these.

To find the current going through one of the alternators, (*a*), it will be convenient to find the current in that branch due to each alternator separately, and algebraically add the two partial currents. Suppose first that only (*b*) is working, and that the current in the external circuit is $C \sin p\,t_1$. The difference of potential at the junctions $= C\,R \sin p\,t_1$.

The current in (*a*) will be

$$= \frac{C\,R}{\sqrt{r^2 + p^2\,L^2}} \sin (p\,t_1 - \theta_1). \quad \text{Where } \tan\theta_1 = \frac{p\,L}{r}$$

The current in (*b*) being the sum of the currents in R and (*a*) will be

$$= \frac{C\,R}{\sqrt{r^2 + p^2\,L^2}} \sin (p\,t_1 - \theta) + C \sin p\,t_1,$$

or expanding and putting $\sqrt{r^2 + p^2\,L^2} = a$

$$= \frac{C\,\beta}{a^2} \sin (p\,t_1 - \theta_2)$$

β being $= \sqrt{(a^2 + R\,r)^2 + (R\,p\,L)^2}$ and $\tan\theta_2 = \frac{R\,p\,L}{a^2 + R\,r}$

The impressed E.M.F. in (*b*) must then be

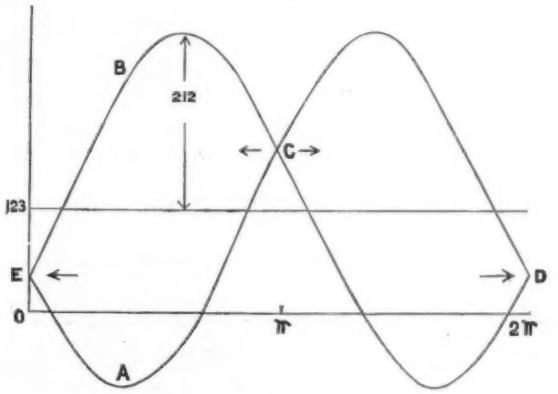
$$= \frac{C\,r\,\beta}{a^2} \sin (p\,t_1 - \theta_2) + L\,p\,\frac{C\,\beta}{a^2} \cos (p\,t_1 - \theta_2) + C\,R \sin p\,t_1$$

The first term being the E.M.F. necessary to overcome the ohmic resistance; the second the back E.M.F. of self-induction; and the third, the E.M.F. keeping up the difference of potential at the junctions. By expanding, this may be reduced to

$$= C\,\gamma \sin (p\,t_1 + \theta_3) \text{ where } \gamma = \sqrt{(2\,R + r)^2 + p^2\,L^2}$$

$$\tan\theta_3 = \frac{p\,L}{2\,R + r}$$

FIG. 3.



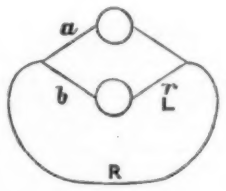


FIG. 4.

Thus an impressed E.M.F. of $C\,\gamma \sin (p\,t_1 + \theta_3)$ in branch (*b*) will give a current of

$$\frac{C\,R}{a} \sin (p\,t_1 - \theta_1) \text{ in } (a),$$

and a current of $\frac{C\,\beta}{a^2} \sin (p\,t_1 - \theta_2)$ in (*b*).

By making $C = \frac{E}{\gamma}$ and $p\,t = p\,t_1 + \theta_3$, we see that an impressed E.M.F. of $E \sin p\,t$ in branch (*b*) will produce a current of

$$\frac{E\,R}{a\,\gamma} \sin (p\,t - (\theta_3 + \theta_1)) \text{ in } (a),$$

and a current of

$$\frac{E\,\beta}{a^2\,\gamma} \sin (p\,t - (\theta_3 + \theta_2)) \text{ in } (b).$$

By a similar process we can find that an impressed E.M.F. of $E \sin (p\,t + \theta)$ in (*a*) will

give a current of $\frac{E\,R}{a\,\gamma} \sin (p\,t - (\theta_3 + \theta_1 - \theta))$ in (*b*)

and „ „ $\frac{E\,\beta}{a^2\,\gamma} \sin (p\,t - (\theta_3 + \theta_2 - \theta))$ in (*a*).

Hence the total current, when both alternators are working, through the lagging alternator (that in branch (b))

$$= \frac{E\beta}{a^2\gamma}\sin(pt-(\theta_3+\theta_2)) - \frac{E\,R}{a\,\gamma}\sin(pt-(\theta_3+\theta_1-\theta)) \quad (1)$$

and the total current through the leading alternator (in the branch (a))

$$= \frac{E\beta}{a^2\gamma}\sin(pt-(\theta_3+\theta_2-\theta)) - \frac{E\,R}{a\,\gamma}\sin(pt-(\theta_3+\theta_1)) \quad (2)$$

By expanding the sine and cosine, these may be expressed as follows :—

Current through lagging alternator $= E\sqrt{X^2+Y^2}\sin(pt-\omega)$

" " leading " $= E\sqrt{A^2+B^2}\sin(pt-\xi)$

where

$$X = \frac{\beta}{a^2\gamma}\cos(\theta_3+\theta_2) - \frac{R}{a\,\gamma}\cos(\theta_3+\theta_1-\theta)$$

$$Y = \frac{\beta}{a^2\gamma}\sin(\theta_3+\theta_2) - \frac{R}{a\,\gamma}\sin(\theta_3+\theta_1-\theta)$$

$$A = \frac{\beta}{a^2\gamma}\cos(\theta_3+\theta_2-\theta) - \frac{R}{a\,\gamma}\cos(\theta_3+\theta_1)$$

$$B = \frac{\beta}{a^2\gamma}\sin(\theta_3+\theta_2-\theta) - \frac{R}{a\,\gamma}\sin(\theta_3+\theta_1)$$

$$\tan\omega = \frac{Y}{X} \qquad \tan\xi\frac{B}{A}$$

The difference of phase between the current through the lagging alternator and its E.M.F. is ω, $\therefore$ the watts or work per second done by it

$$= \tfrac{1}{2}E\,.\,E\sqrt{X^2+Y^2}\cos\omega$$

$$= \tfrac{1}{2}E\times E\sqrt{X^2+Y^2}\times\frac{X}{\sqrt{X^2+Y^2}} = \tfrac{1}{2}E^2X$$

$$= \tfrac{1}{2}E^2\left\{\frac{\beta}{a^2\gamma}\cos(\theta_3+\theta_2) - \frac{R}{a\,\gamma}\cos(\theta_3+\theta_1-\theta)\right\}$$

The difference of phase between the E.M.F. of the leading alternator, and the current through it $= (\theta+\xi)$, and The watts

$$= \tfrac{1}{2}E\,.\,E\sqrt{A^2+B^2}\cos(\theta+\xi)$$

$$= \tfrac{1}{2}E\,.\,E\sqrt{A^2+B^2}\left(\frac{A\cos\theta - B\sin\theta}{\sqrt{A^2+B^2}}\right)$$

$$= \tfrac{1}{2}E^2(A\cos\theta - B\sin\theta)$$

$$= \tfrac{1}{2}E^2\left(\frac{\beta}{a^2\gamma}\cos(\theta_3+\theta_2) - \frac{R}{a\,\gamma}\cos(\theta_3+\theta_1+\theta)\right)$$

In fig. 3 the "work-difference of phase" curves are plotted as before, A is lagging alternator's curve, and B the leading one's.

The particular values taken are—

$r = 5$ ohms, L = ·02 henries, $p = 500$, R = 50 ohms, E = 100 volts, θ varies, θ_1 is found to be 63° 7′, θ_2 53° 6′, and θ_3 5° 25′.

The equations reduce down to—

Watts of lagging alternator $= 123 - 212\cos(\theta - 68°\,52')$

" " leading " $= 123 - 212\cos(\theta + 68°\,52')$

On examining the curves it will be seen that for any difference of phase between 0 and π the leading alternator is doing more work than the other, it will, therefore, tend to slacken speed, and the lagging one will tend to increase its speed, consequently, the difference of phase will become less, this will go on till the difference of phase is zero, and this will be a point of stable equilibrium. For any difference of phase between π and 2π, the lagging alternator is doing *more* work than the other, it will therefore tend to slacken and the leader to increase its speed so that the difference of phase increases until it reaches 2π, which is the same thing as zero. The point D or E is a point of stable, but the point, C, is one of unstable equilibrium. Hence alternators independently driven in parallel get into step and tend to keep together, a result opposite to that we obtained when the alternators were in series.

ARC LIGHTING.

By E. TREMLETT CARTER.

(*Continued from page* 368).

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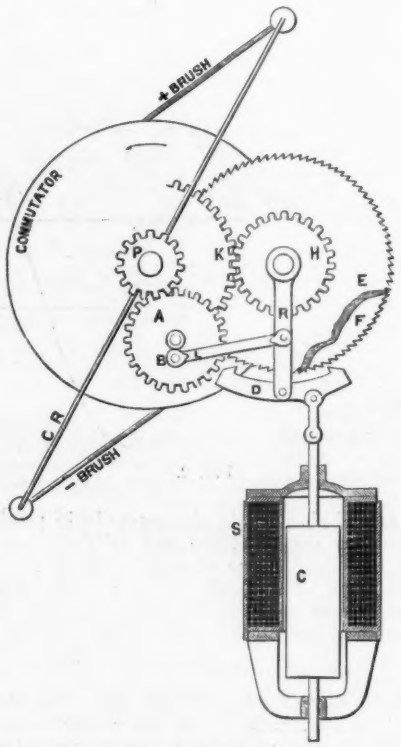
XI.

THE practice of regulating a dynamo for constant current by automatically shifting the brushes on the commutator of a closed coil armature is exemplified in the well-known machines built by Messrs. Statter & Co. Through the kindness of that firm the author is enabled to publish some particulars regarding these dynamos. It will be understood that since the distribution of potential around the commutator of a closed coil armature is not uniform, but varies from zero at two points to a maximum at two other points on an axis at right angles with the axis of the former two, it will be theoretically possible to put any desired voltage between these limits on the brushes by sliding the brushes round the commutator. By means of an automatic governor the position of the brushes at any moment may be arranged to be such that there will always be the same current in the external circuit at all loads. It will not, however, always be practically possible to do this, for, as we saw in our study of the "Phœnix" dynamo, any attempt to shift the brushes will result in sparking, unless special means are adopted to overcome this consequence of self-induction. In the Statter dynamo the means adopted for this purpose are the recessing of the two polar surfaces in such a way as to cause a uniform gap field over the entire range of motion of the brushes. The curvature which is given to the poles is such that the distribution of magnetic lines at the polar surfaces will be uniform, with the result that the E.M.F. of self-induction will be balanced at all positions of the brushes, and regulation by shifting the brushes becomes a practical possibility. The regulating mechanism is shown in fig. 30. It consists of a pinion, P, mounted and keyed on



, R, Centre line of rocker.

FIG. 30.

the spindle of the dynamo, gearing into a toothed wheel, A, which is mounted loosely on an idle spindle and carries a reciprocating link, L. This link is fitted by means of a sleeve upon an eccentrically mounted stud on A, and is attached in a similar manner to the rocking lever, R. This

lever is, at the upper end, loosely fitted on a second idle spindle, and, at the lower end, carries a double pawl and ratchet gear, D. The pawl on the left hand side can gear into the ratchet wheel, E, and will do so when the current falls too low; the other pawl gears into the ratchet wheel, F, when the current is too large; when the current is normal neither pawl is engaged. The current affects the ratchet gear by means of the solenoid, S, and the soft iron core, C. When the current becomes too strong the solenoid lifts the core and tilts the right hand pawl on to the wheel, F; and when the current falls below normal strength, the solenoid lowers the heavy core and allows the left hand pawl to gear with E. mode of fitting this regulator on to the commutator end of the dynamo is shown in fig. 31.

Open coil dynamos are chiefly represented by the Brush and Thomson-Houston machines, the former of which we will now study. Without going into historic details of the stages through which this type of dynamo has passed, we may at once pass on to the latest and most improved pattern of Brush machine, merely remarking in passing that while the general design of the dynamo has suffered little change and the mode of winding is substantially unaltered, there have been important improvements introduced into the details which have materially increased the efficiency and output of

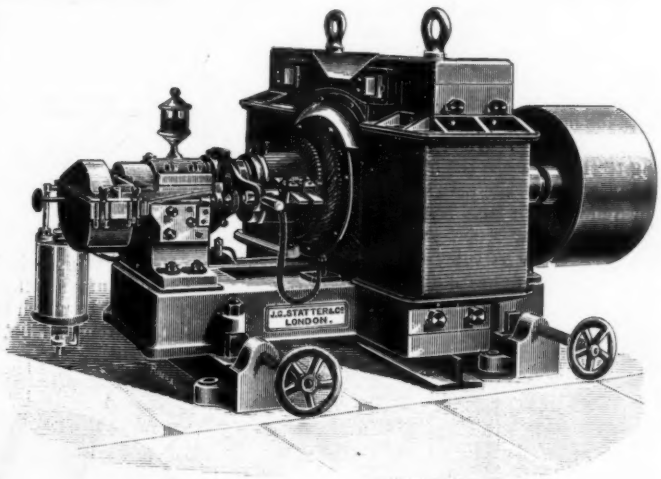


FIG. 31.

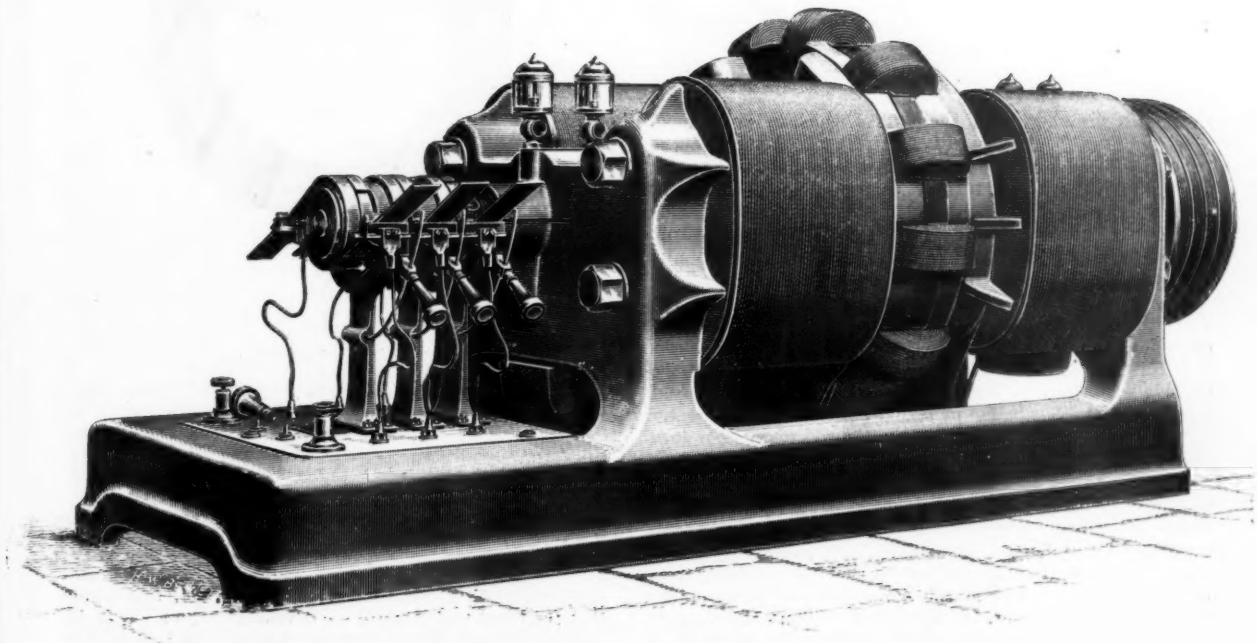


FIG. 32.

Both E and F are keyed to the second idle spindle, and this spindle also carries a toothed wheel, H which is keyed on to it and which gears with the segmental wheel, K. This toothed segment is fixed to the brush rocker, and the motion which is imparted to it through H, will move the brushes over the commutator. According to the direction of this motion, so will the voltage at the brushes either be increased or diminished. It will be seen that the effect of the gear is to tend to keep a constant current in the solenoid, S, which should be placed in series with the arc lamps. The parts, P, A, L, and R, are in constant motion; but the other parts only move when the brushes are actually being shifted. The the machine. These improvements we shall refer to as we study the details into which they have been introduced. We may take for illustration the largest and most commonly used (for public lighting) of these dynamos, namely, the 60-light machine, known as the "No. 8 L." This machine is shown in fig. 32, and is capable of running 60 10-ampère lamps of 2,000 nominal candle-power, developing 3,000 volts at the terminals at a speed of about 800 revolutions per minute. It will be seen that there are two field magnets, one on either side of a ring shaped armature. These are so wound that their similar poles are opposed, thus sending the lines of force through the armature in the plane of rotation and not

across the direction of motion. Thus, the two magnets seen in the figure may both be of north polarity, the hidden ones being south. The pole pieces are formed of extended cheeks, embracing a large portion of the circle; and the winding is in series with the external circuit. The armature, in its external appearance, resembles the Pacinotti ring, or an iron ring with coils wound between projecting teeth; but in its internal arrangement it is very different. In the 8 L machine there are 12 separate bobbins, mounted at equal distances on a wrought-iron ring, in recesses formed in the ring for the purpose. The bobbins are rectangular in shape, rounded off at both ends, and one end of each coil is connected to the corresponding end of the diametrically opposite coil, the other ends of all the coils being only connected to the commutator strips. There are three commutators, each controlling the current from four coils, *i.e.*, two pairs. The core on which the armature coils are carried was originally made of a cast-iron ring, machined up to the required shape, with radial slots for holding the bobbins and a number of circumferential slots for preventing excessive eddy currents in the projecting teeth. Within the last three years, however, this mode of constructing the core has been abandoned, in view of the researches which have been made into the formation of eddy currents in iron core; and the ring is now made of wrought-iron strip in the following manner. Fig. 33 gives a diagrammatic representation of a

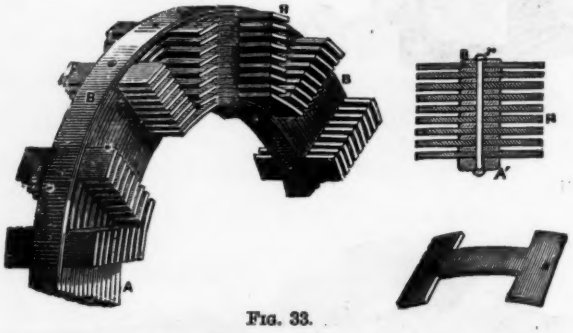


FIG. 33.

segment of the ring and of the parts of which it is composed. There is, first of all, a spiral band or ribbon of sheet iron, B, which is built up on an inner former or foundation ring, A'. Between each successive turn in this spiral and the adjacent one, a number of H-shaped curved stampings, one of which is shown in the fig., are sandwiched; the entire structure being held together by means of steel pins, *r*, passing radially from the outside to the inside through both ends of all the H-shaped stampings and the continuous spiral of iron ribbon. In this way a ring of the original shape is built up, though differing from the cast-iron ring in having a much more perfect degree of lamination. It should be mentioned that the relative thickness of the ribbon and the ring is not conveyed by the figure, there being in actual practice a much greater number of turns of the ribbon and many more stampings than are shown. The direct effects of this alteration have been to increase the net value of the exciting field, by getting rid of the opposing fields of eddy currents, thus enabling the dynamo to give the same E.M.F. at 34 per cent. lower speed; to increase the limit of output of any given machine by 50 per cent., because of the lessened heating in the iron; and to increase the commercial efficiency of the machine by 15 per cent. for equal loads. Thus, the old type of machine, which formerly could supply only 40 lamps, is replaced by a machine of the same size capable of running from 60 to 65 lamps; while the smaller types are found to have improved in something of the same ratio, the 16-light dynamo, for example, being now capable of driving 25 lights.

To understand the cycle of operations in the armature coils, and the action of the complicated commutator, it will be advisable, at first, to consider only the two pairs of coils which are associated with one of the three commutators. These four coils are necessarily disposed at right angles on the armature core, so that one pair comes into maximum action when the other is on the neutral line, and both pairs are in actions of exactly equal magnitude when they both make 45° with the neutral line. Accordingly, when one is in maximum action the other pair will be cut out; while, when both pairs are in the neighbourhood of 45° with the neutral line they will be placed in parallel. The commutator to which they are directly connected provides for these interchanges. Each commutator is two-fold in its action, rectifying the alternating current in each pair of coils and coupling up or disconnecting the two pairs. It consists of four T-shaped pieces of sheet metal, folded over the surface of a cylinder and connected to the coils, as shown in fig. 34. In this

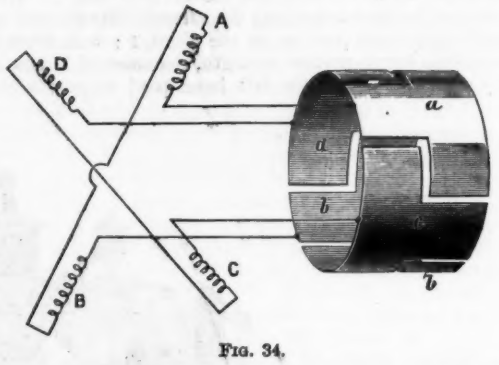
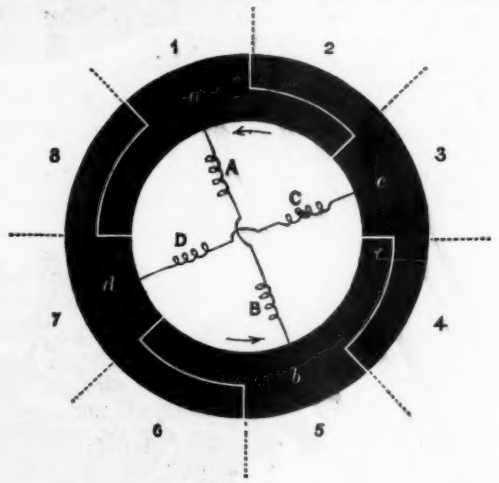


FIG. 34.

fig., and the companion fig. which follows it, capital letters are given to the coils, and small letters of the same name to the commutator strips, to which the coils are joined, and the parts are similarly lettered in both figs. Fig. 35 represents



1. $\frac{A\,B}{C\,D}$ active
   cut-out.
2. A B and C D in parallel.
3. $\frac{C\,D}{A\,B}$ active
   cut-out.
4. A B and C D in parallel.
5. $\frac{A\,B}{C\,D}$ active
   cut-out.
6. A B and C D in parallel.
7. $\frac{C\,D}{A\,B}$ active
   cut-out.
8. A B and C D in parallel.

FIG. 35.

diagrammatically the connections in fig. 34, and assumes that the commutator strips are developed upon a flat surface, with the brushes sliding over the ring-shaped portion which has been blackened. When the positive brush is in contact with the arc marked 1, the pair of coils, C and D, is cut out, and current is derived only from A and B. This condition of things lasts for one-eighth of a revolution; after which, in position 2, the two pairs are placed in parallel for an equal period. Then, for the same length of time, the pair C and D is alone active. The diagram gives the cycle of operations in full; and it will be seen that each pair is in circuit by itself twice during every revolution, that it is cut out twice during every revolution, and that it is in circuit in parallel with the other pair four times during every revolution. Each coil is idle during one-fourth of the whole time.

If the armature consisted of only four coils and one commutator, there would be very considerable fluctuations in the terminal voltage, though this quantity would never fall quite

to zero. The amount of fluctuation can be determined by superposing the E.M.F. curves of the separate pairs of coils, with a lag of 90°, and no very serious error will be introduced by assuming the sine law of variation. Several objectionable features would be introduced by such a large fluctuation of external current, principally owing to self-induction and eddy currents in the lamp mechanism and to induction along the line. The arc, too, would not be silent under such rapidly varying currents, but would emit a singing noise. Accordingly, the fluctuation has to be reduced; and the manner in which this is done will now be considered.

(*To be continued.*)

CORRESPONDENCE.

Arc Lighting.

Prof. Carhart is unwilling to be placed in the position of defending the closed-coil dynamo as opposed to the open-coil type. At the same time he traverses all that I have stated in regard to the defects of the former. The paragraph from which Prof. Carhart quotes the sentence to which he objects is taken from a part of my articles in which the relative merits and demerits of open and closed coil windings were being considered. With what little justice, then, can he accuse me of "skilfully shifting the point of criticism," so as to put him "in the position of defending the closed coil high pressure dynamo for arc lighting in opposition to the open coil type." It is quite true that, as he says, he does not once mention the word *open* coil in his letter. But his defence of the closed coil is, as I shall show, *ipse facto* a disparagement of the claims of the contrary type of winding. One cannot deny the existence of all that it is asserted makes the one inferior to the other, without implying that it is really superior.

But is not Prof. Carhart's double position a self-destructive one? On the one hand he is unwilling to take up a position adverse to the superior claims of open coil dynamos as a class (*vide* his second letter), while, on the other hand, he emphatically refuses to recognise the existence of those limitations in the design and working of closed coils (also as a class) which are the sole ground and basis of their inferiority. For it is not too much to say that if there is no foundation for the objections I have raised against closed coil armatures, a very great mistake has been made in ever building dynamos of the open coil type. If, as Prof. Carhart tells us, we are not to be afraid of the commutator of closed coil machines, then "what devil was't that cozened us" into designing open coil windings with their imperfect devices for cutting coils out of circuit every revolution? Once admit that there is no insuperable difficulty (insuperable, of course, when financial questions are included) in designing high pressure closed coil commutators, then every other consideration of economy in dynamo design must irresistibly impel us to adopt that type of machine. But Prof. Carhart is "unwilling" to assume this preference. I can only ask him—why?

As to the award for an open coil machine, which Prof. Carhart tells us he wrote at the Chicago Exhibition, in what way does it tend to show that he "is not advocating one type of dynamo as against the other," or how does it enter into the debate? On what grounds was that award made? Was it that Prof. Carhart advocated the award on the ground of the superiority of this machine over other machines of the same class? If so, it cannot be said to illustrate his fairness of dealing between two opposing classes, but only shows his sagacity and skill in picking out the best sample of one particular class. Or, was it that the award was made on the ground that this machine ran better, gave a higher efficiency, regulated better, or gave a greater output than any other machine? Even then, the award had nothing to do with the relative merits of the windings. Or, perhaps, after all, the award was made because of the obvious superiority of this open-coil machine over the various magnificent samples of closed-coil machines with which Prof. Carhart tells us the Machinery Hall was stocked. And if so, in what way are we to interpret this as showing that Prof. Carhart is "not advocating one type as against the other;" or how are we to understand his assertion that he is "unwilling" to pit the one type against the other? Either this award was made because of the superiority of the open-coil winding, or it was not. If it was not, it has not the remotest connection with the debate; while if it was, it shows that Prof. Carhart could cast his vote in opposition to the very type of winding he wishes me to extol, and it tells us of which class of winding he thinks most highly.

It is an illogical position into which Prof. Carhart seeks to drive me, and which he himself appears to hold. For his facts and figures I am only too thankful; it is evident that considerable progress has been made in the design of closed-coil armatures both in America and on the Continent of Europe. English engineers have practically abandoned this type for high pressures, and for the very reasons which I gave in my articles. But, if it can be proved that all the commutator difficulties *have been got over without undue cost in the manufacture of the machine*, it will be easy for the present advocates of open-coil machines to transfer their affections. But I am still sceptical. While I quite agree with Prof. Carhart in so far as he seeks to show that those difficulties are *physically* surmountable, I cannot agree with him that they have been overcome along the lines of the best commercial practice. When I am able to think to the contrary, it seems to me that it would be impossible to hold the illogical position of likewise defending the open-coil type, or of being unwilling to set up a favourable comparison between the closed-coil machines and those with open winding. It seems to me that he who believes in a good commercial high-pressure closed-coil commutator should not have one good word to say for dynamos of the makeshift open-coil type.

E. Tremlett Carter.

The Maximum Efficiency of Arc Lamps with Constant Watts.

Under the above heading in your number of October 27th, you published some data obtained from Prof. Carhart, and from these data drew conclusions which I believe to be erroneous, and which may mislead engineers who are studying this question. It appears that Prof. Carhart in making his experiments on the efficiency of arcs with constant watts, finds that a higher efficiency in candle-power per watt is obtained at 55 volts than at 45 volts. These results differ very widely from those obtained by myself who have been experimenting on this subject during the past 18 months. I have not yet completed the whole of my investigations, but I have already done enough to show that the maximum efficiency of arc lamps with constant watts is at the time when the volts measured across the arc do not exceed from 42 to 43, in fact that the limits between which this maximum efficiency lies is between 40 and 44 volts. I can only account for the wide discrepancy between my results and those of Prof. Carhart by the fact that he has been using American carbons, whereas my experiments have been carried out with the best German makes of carbons. I think all American engineers admit that with the German made carbon, using cored positives and solid negatives, light giving efficiencies can be obtained greatly superior to those obtained by Prof. Carhart, and it is not surprising that Prof. Carhart finds that with such carbons it is best to use a wide open flaring arc.

I am not aware in what way Prof. Carhart has measured his candle-power, but presume that it is the mean or average candle-power of the lower hemisphere. If this is the case the results would be very much influenced by the diameter of carbons used; if he followed the American practice of using the same size carbons for top and bottom he would certainly get better results with long arcs than with short ones, whereas on this side of the Atlantic we believe that our greatly improved efficiencies are partly due to the fact that most of us use large cored positives and small solid negatives. This arrangement greatly reduces the area of the dark spot immediately under the lamp when short arcs are used. At any rate, in the course of my experiments I have found it not at all difficult with a lamp of 450 watts having 42 volts at the arc, to get a mean candle-power at the lower hemisphere of 1,650 candles, which result is about 50 per cent. better than that obtained by Prof. Carhart.

R. E. Crompton.

November 6th, 1893.

Electrical Education.

The letters of Mr. Maycock and others on this subject indicate a somewhat general amount of dissatisfaction with the City and Guilds system as it now stands. Undoubtedly the ordinary grade is too difficult and extensive for the average student to master successfully in one winter's course of 30 or 40 lessons, but the fault, if any, has been on the right side, and the examiners have done well to set up a standard which can only be reached by genuine and honest work on the part of both teachers and students.

The objections urged seem, in great measure, to be met by the introduction of the preliminary examination, though it is impossible to judge exactly how its syllabus will be interpreted by the examiners until one or two examination papers have been issued. It is to be hoped that the questions set in this stage will not be of too difficult a nature, and fairly within the reach of artisan students, in order that they may be encouraged by their success to attack the ordinary grade work subsequently; and if this proves to be the case, probably it will be unadvisable to lower the ordinary grade standard in any way.

It is true there are usually a few somewhat difficult questions, but these are inserted for honours' students also, and as only six can be attempted out of 12 set, they can generally be avoided. In this year's paper there are at least six—perhaps eight—questions which should not be too difficult for most students, and this does not seem an unreasonable allowance.

I doubt whether any good result would be obtained by raising the standard of the honours grade; here it is the wide scope of the questions, and the large amount of ground to be covered which have to be reckoned with, and any further increase would probably put a premium on the work of the merely mathematical student, at the expense of the more practical man—a result to be greatly deprecated.

I fully agree with your other correspondents as to the desirability of granting certificates on the preliminary grade.

E. E. Brooks,
Instructor Electrical Classes, Leicester Technical School.

Report of Tests on the Epstein Accumulators.

Sir D. Salomons, Bart., in his book upon "Electric Light Installations and the Management of Accumulators," states in page 14, when referring to the Planté type :—"The chief drawback to this type of cell is that frequent reversals are necessary in order to obtain good storage capacity, and when the maximum capacity is reached, the plates become rotten." Will you kindly inform me through your valuable paper—the ELECTRICAL REVIEW—if Sir D. Salomons's remarks apply to the Epstein accumulators ?

J. W. Dunn.

November 7th, 1893.

[No! The manufacture of Epstein plates is quite different to the old process of forming those of the Planté type.—EDS. ELEC. REV.]

TWO SUCCESSFUL COMPANIES.

THE *Investors' Review* for November, in its company notes, has well-written and interesting historical accounts of the progress, dating from their inception, of two very successful cable and general telegraph undertakings, *i.e.*, the Telegraph Construction and Maintenance Company, Limited, and the India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited. We consider the comments well worth reproducing, and we therefore give them, as follows :—

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED, is an industrial undertaking which has enjoyed a long period of prosperity. Its inception took place just thirty years ago, immediately preceding the successful establishment of ocean telegraphy. The company was formed in April, 1864, for the purpose of uniting the business of the Gutta-Percha Company with that of Messrs. Glass, Elliott & Co. The latter firm manufactured, laid down, and maintained telegraph lines, while the Gutta-Percha Company supplied the inner cores of the cables, and it was with a view of closer working, greater economy, &c., that the concerns were turned into the Telegraph Construction and Maintenance Company. Of the capital of £1,000,000, three-fourths were first issued in 37,500 shares of £20 each. The important question of what was to be paid for the businesses was a matter of arbitration; Messrs. Glass, Elliot & Co., who had previously bought up the patents of the Gutta-Percha Company, and transferred them at cost price to the new undertaking receiving £397,671, while the other company obtained £163,470, which included £100,000 in fully-paid shares previously handed over. These amounts were rather under expectation, but, whatever may have been thought then, there can be no doubt that, viewed in the light of after success, they were reasonable enough. The original board of directors was a strong one, and, as will be seen, included a singularly large proportion of men destined to become recipients of royal favour. Among them we find the names of Thomas Brassey, Daniel Gooch, John Pender, M.P., Samuel Gurney, M.P., A. S. Finlay, M.P., and A. H. Campbell (of Finlay, Campbell & Co.), and John Smith (of Smith, Fleming & Co.) From the firms taken over there were H. F. Barclay, R. A. Glass, and George Elliot, the latter being now a baronet and the company's present chairman. In fact, he is the only member of the original directors on the existing board. The first important contract entered into was to lay a cable for the Atlantic Cable Company, now known as the Anglo-American Telegraph Company. This cable, of about 2,300 nautical miles—a nautical being rather less than a land mile—was manufactured in 1864, and the *Great Eastern* was duly fitted out by the Telegraph Construction Company to lay it. But this was not successfully accomplished until the third attempt, though, whether the earlier failures were due to malicious interference or to the hunger of the sharks is uncertain. However, the cable was eventually laid, and with it was also laid the foundations of the future success of the Telegraph Construction Company. One sovereign per word was the cable tariff, which, compared with the humble shilling of to-day, looks costly. The Construction Company was paid only partly in cash for this work, taking the remainder in debentures and shares in the Atlantic Cable Company; but as these were not long in going to a considerable premium, all turned out well. It was not the actual payment for this cable which was of such importance; it was the start it gave to submarine cable laying. As time went on, companies were formed to establish cable communication with all parts of the world. Then the Construction Company came in for a large business, and its success was assured.

In 1869 the capital of the company was reduced from £747,000 in £20 shares, to £448,200 in £12 shares, and in 1888 the interest on the £150,000 debenture bonds was lowered from 6 per cent. to 5 per cent. These bonds are still in existence, and are renewed every five years. The company also issued second bonus trust certificates to the amount of £186,750 in sums of £5, £25, £50, and £100. The trust was composed of Brazilian Submarine and Globe Telegraph shares, and the dividends paid to holders varied with the dividends paid by these two telegraph companies. But this is now a thing of the past, for in 1881 one-half the amount of the certificates was repaid to the holders and in 1888 the remaining half. Handsome dividends have always been paid by the Telegraph Construction Company, reaching on more than one occasion to 25 per cent. This dividend was paid in 1873, but the following year it dropped to 20 per cent., and in 1875 to 15 per cent. In 1876 it was 20 per cent., and this dividend was paid every year down to 1892, when it fell to 15 per cent. This is not at all a bad record, and an original subscriber who has seen the price of his shares up to 48½ per cent. has much reason to be thankful. All the same, it would be unreasonable to expect such thorough good times to continue indefinitely, and the inevitable check seems to have come at last. For the four years ended with 1891, the average profits were £91,300, but for 1892 they were only £51,579. This is a heavy drop, and fully accounts for the reduced dividend, and also for the reduction of £16,000 in the amount carried forward. The balance-sheet does not reflect credit upon its compilers. According to this, there is a reserve fund of £50,056, at which figure it has stood for several years. Then there is an item styled "Debts owing by the company, and reserves for insurance, debentures, and contingencies, and suspense account for unfinished work, £467,592." It is so far satisfactory that this total is £38,000 under what it stood at five years ago, but it is the clapping of the various amounts under one head that we object to. Debts owing by the company should be given separately, as should also suspense accounts for unfinished work. On the other side of the balance-sheet we find property, including premises, stock, plant, and leases, figuring for £577,720, while at the end of 1888 the amount was only £379,100. Then there are debts owing to the company, £128,784, compared with £306,012 a year ago, which shows that, owing to the dull times, debtors have been shepherded up, while cash in hand in the 12 months has declined from £93,505 to £60,614. The concluding item is "sundry securities," the value of which is put at £434,982. What these securities are we know not, but there can be little doubt that they are shares or debentures in telegraph companies accepted for work done, and what their real value is, seems very problematical. The balance-sheet, to our mind, carries on the face of it retrogression. We do not say all vitality has left the concern, but we certainly think its best times are over. The company undoubtedly did a much smaller amount of work during 1892 than in previous years, which was, to some extent, due to the prevailing depression in commercial circles. It has laid a large number of cables in its time, and perhaps there is still scope for telegraphic enterprise. Fortunately, the company does not depend solely upon cable laying, as a good revenue comes from repairs and such like. But competition is now keen, and the day of large profits is gone. When the Telegraph Construction Company was started, cable laying was in its infancy; things are very different now.

THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED, is also a well-established industrial undertaking close on 30 years old. It was started as far back as 1864 to take over and extend the India-rubber and telegraph cable works of Messrs. S. W. Silver & Co., of Silvertown in Essex, and to add to their operations those connected with gutta-percha, and with a West Indian gum called balata, used in telegraphic machinery. It was not long before the capital was increased from £500,000 to £1,000,000 in order to

buy up the interests of certain city capitalists who were promoting another company to work gutta-percha, the latter taking £100,000 in shares in the amalgamated company, with the "option" of another £50,000 in shares. Interests were also bought up belonging to those who held the privilege of manufacturing gutta-percha and India-rubber cables in France and Belgium, for £65,000, and £100,000 of the company's stock was placed at their disposal to be taken at par. So well did the company prosper that for the three years ended with 1871 the average dividend exceeded 11⅛ths per cent., and the shares changed hands at £71 apiece. But a period of depression came along, and although 5 per cent. was paid for 1872, no dividend was forthcoming for 1873 or 1874. In 1875 there was a debit balance of £66,800. Things then began to mend, and, not only was this debit made good in 1876, but a small balance was carried forward. In 1877 there was still no dividend, but there was a balance to carry over of £21,055. The following year saw a change in the company's history. A dividend of 7½ per cent. was paid, and the capital account was reconstructed, the shares being reduced to £10 each, while the subscribed capital was made £312,000, and the authorised capital was raised to £812,000. How the concern has progressed and grown since the reconstruction will be gathered from the following figures:—

Year.	Capital including debentures.	Gross profit.	Net profit.	Dividend and bonus.	Amount of reserve.	Property (land, machinery, and steamships).
	£	£	£	Per cent.	£	£
1879	412,000	99,688	52,354	10	50,000	239,951
1881	412,000	132,204	77,226	15	100,000	362,118
1883	412,000	119,796	50,370	15	200,000	437,190
1884	412,000	139,740	71,968	15	220,000	446,344
1885	516,000	137,223	68,557	15	275,000	453,371
1886	616,000	136,268	61,387	15	275,000	463,746
1887	616,000	71,313	13,174	10	275,000	460,918
1888	616,000	135,831	58,886	10	275,000	462,208
1889	616,000	141,458	59,542	10	275,000	463,640
1890	616,000	150,925	67,971	10	300,000	472,952
1891	616,000	173,574	82,102	12½	325,000	483,546
1892	700,000	190,766	102,161	12½	400,000	489,745

These results show up almost equally as well as those of its rival the Telegraph Construction Company. With a slightly larger amount of capital the net profits of the India-rubber Company for the last five years have averaged £73,605, compared with £83,375 of the Construction Company. The Board of the India-rubber Company has never aimed at paying such large dividends as the other company, but while the reserve fund of the Construction Company has remained stationary during the five years at £50,056, the reserve fund of the India-rubber Company has in the same period been raised from £275,000 to £400,000, of which increase only £43,110 represents premium on new shares.

Among the principal work done by the company may be mentioned the laying the cable from Marseilles to Algiers in 1879, for the French Government; the direct line of cable between Valparaiso and New York; cables between Spain, the Canary Islands, and Senegal; cables 3,500 miles long for the West African and African Direct systems; 2,200 miles long for the South American Cable Company, and 2,600 miles long for the Central and South American Telegraph Company.

The balance-sheet discloses a tolerably strong position. The debenture issue is only £200,000 against a share capital of £500,000, and the reserve fund is £400,000, exclusive of a steamers' maintenance fund of £10,000. This reserve fund is in the business, but against it may be placed cash in hand on deposit £63,327; stock-in-trade, £221,121; and cash and stock at agencies, £155,352. In addition, the company holds debentures and shares in other companies to the amount of £227,865. This holding probably represents payment for work done, but the dividends it brings in are, no doubt, sufficient to cover the company's debenture interest. Debts owing by the company and suspense account amounting to £77,438 are off-set by debts owing to the company, £105,489. Altogether the position seems satisfactory. Orders for submarine cables are now keenly competed for and profits are not what they were, but the company has other sources of revenue from its general manufactures, and it has so far come through the depression in trade very well. Although the shares stand at a premium of £12, they yield a purchaser about 5⅝ per cent. They carry no liability, and there is a pretty free market for them.

ARREST OF HARNESS AND HIS ASSISTANTS.

POLICE COURT PROCEEDINGS.

ON Wednesday, at the Marlborough Street Police Court, Cornelius Bennett Harness, 47, of Heathside, Potter's Bar, Hertfordshire, who was described as the managing director of the Medical Battery Company, Limited, was charged on a warrant, granted by Mr. Hannay, "for that he did unlawfully combine, conspire, confederate, and agree with J. Montgomery M'Cully, and other persons, by false pretences and fraudulent advertisements in newspapers, and otherwise, to defraud; and for that he did unlawfully conspire, combine, confederate and agree with other persons to obtain, by a false and fraudulent pretence, the sum of £52 10s., and other sums of money, from Jeremiah Brasyer with intent to defraud; and for that he did unlawfully conspire, &c., with other persons, to obtain the sum of £2 2s. from one Kate Wilcocks, the sum of £26 5s. from Frederick Theobald Burbage, and the sum of £2 2s. from one William Hibberdine Manners, in each case with intent to defraud."

James Montgomery M'Cully, 47, described as a physician, of Blandford Mansions, East Street, Marylebone, was charged with conspiring with Harness and other persons in the alleged offences.

Mr. Thomas Terrell, barrister, appeared for Colonel Brasyer.

Mr. Avory appeared for Harness, and Mr. F. Dodd for M'Cully.

Mr. TERRELL said that he proposed simply to call evidence of the arrest, and then to ask for a remand.

Mr. AVORY said that he could offer no objection, as he knew nothing about the charges, and would like time to see the informations. He should also like to know the names of the other persons against whom, he understood, warrants had been issued.

Mr. TERRELL said that he was willing to give the names privately to his friend.

Mr. AVORY said that if Mr. Hollier was one of those persons, he was present in court and ready to give himself up.

Mr. HOLLIER hereupon signified his presence among the public at the back of the court. A detective officer immediately went round and conducted him to Marlborough Mews Police Station, which is situated behind the court building, and formally charged him. He was then brought back into the court and placed in the dock with the other prisoners.

Detective-serjeant WEATHERHEAD, of the D Division, said that last evening, about half-past nine, he went to Harness's private house, and told Harness that he and Serjeant Moore, who was with him, were police officers. He read his warrant to him, and Harness replied, "All right. I was expecting this. You see I am not alarmed. I will go with you. This is only a plot to cause our company further indignity. I know all the names of the persons complaining in the warrant. I have civil proceedings now pending with them. I have never seen nor handled their money. I am only the chairman of the company. Someone will have to pay for placing me in this position." He (the officer) conveyed him to the Tottenham Court Road Police Station, where he was charged on the warrant. He made no further statement.

Mr. AVORY: This house at Potter's Bar is where he was residing with his family? You have no reason to doubt that?

Serjeant WEATHERHEAD: Certainly not.

Detective-serjeant MORGAN, of the B Division, said that at half-past eight last evening he arrested Dr. M'Cully at his residence. When I read the warrant to him, Dr. M'Cully said, "I suppose this is Harness's affair?" He (the officer) replied "Yes." Dr. M'Cully then exclaimed, "Well, I know no more about it than the man in the moon. I was only a paid servant—a professional man—and had nothing whatever to do with any money." He (the officer) conveyed him to Tottenham Court Road, and charged him. He said nothing more. When Hollier was charged, he made no reply.

Mr. AVORY: Up to the time of Hollier's surrender no attempt had been made to arrest him, I suppose?

Serjeant MORGAN: I went to his office this morning, and found he was not there.

Mr. AVORY: Of course, because he had come here.

On the question of bail, Mr. AVORY said that everybody knew that these proceedings were the outcome of attacks made by a newspaper upon Mr. Harness. He asked the magistrate to fix bail at a reasonable amount. Mr. Harness had been at his office every day, and yesterday attended a meeting of the company.

Mr. TERRELL asked that substantial bail should be required for Harness and M'Cully.

Mr. HANNAY remanded the prisoners for a week, offering to accept bail in two sureties of £250 for Harness and M'Cully, and one surety of £100 for Hollier.

LEGAL.

MEDICAL BATTERY COMPANY, LIMITED.

IN the Chancery Division of the High Court on Wednesday, the petition of Mr. T. B. Browne for the compulsory winding up of the Medical Battery Company, came before Mr. Justice Vaughan Williams.

Mr. GEO. HENDERSON, counsel for the company, said there was a desire on the part of the creditors generally that the petition should stand over. A committee of six had been formed to consider what should be done in the matter, and they had unanimously resolved to support an application for a supervision order. The receiver appointed by Mr. Justice North in the debenture holders' action had stated in an affidavit that if a compulsory winding-up order was made, the assets of the company would realise hardly anything, and the debenture holders would get nothing. The result of the violent attacks by an evening newspaper against this company and Mr. Harness had been that every person who had bought a belt or appliance from Mr. Harness within the last four or five years had demanded the instant return of his money.

Mr. EBE said he appeared for a creditor and opposed the adjournment.

Mr. BRAMWELL DAVIES on behalf of other creditors also opposed. There had been a meeting held on the previous day at which a resolution for the compulsory winding-up was believed to have been carried by the creditors, but Mr. Harness, who presided, declared that the resolution was lost. This meeting was very uproarious.

Mr. HENDERSON: No, no; fearful. (Laughter).

Mr. DAVIES pressed the Court to deal with the petition at once. His clients desired a compulsory order and the fullest and most searching examination into the promotion of this company.

Mr. JENKINS argued in support of the petition. The petitioner, Mr. Browne, was an unsecured creditor for £200 for work done. The nominal capital of the company was £100,000, all paid up. The company had taken over many electrical patents from Mr. Harness, and carried on its business at extensive premises in Oxford Street. Debentures had been issued, and there were a large number of unsecured creditors, many of whom were pressing their claims. A debenture holders' action had been commenced and a receiver appointed. The company had passed a resolution for winding up voluntarily, on the ground that its assets were not sufficient to pay liabilities, and the receiver had been appointed voluntary liquidator. The date of the company's resolution was November 3rd, but the petition was filed October 27th. The petitioner pressed for a compulsory order.

Mr. JUSTICE WILLIAMS said before he made a compulsory order the petitioner must satisfy him that the rights of the creditors would be prejudiced by the voluntary winding up.

Mr. JENKINS said there were a great many creditors appearing in this case, and the petitioner had not had much time to consider his position. If there was a general consensus of opinion that a supervision order would meet the case, his client would consent.

Mr. HENDERSON said the company would accept that.

Mr. EVE said that was exactly what some of the creditors had expected, and he was instructed to oppose such a compromise.

Mr. MACNAGHTEN opposed a voluntary winding up. The creditors he represented were not satisfied with the receiver as voluntary liquidator.

Mr. BOXALL appealed to the Court not to make the order asked for. He appeared for six shareholders holding 2,651 shares, £5 fully paid or a value of £13,255. A voluntary liquidation was the only way in which the shareholders would get any of their money back.

Mr. JUSTICE WILLIAMS ordered the petition to stand for a week in order that evidence might be prepared of the wish of the shareholders.

THE BEGINNING OF THE END.

THE position of the Medical Battery Company has become such that the principal creditors felt it necessary to meet Mr. Harness and obtain from him, if possible, some definite information. This meeting was held on Tuesday, and though the late managing director attempted to keep out reporters, he was not successful. We shall give a few extracts from the newspaper reports of the meeting, but before doing so we should like to point out that though Mr. Harness is said to have resigned his position at the head of affairs, it is to be assumed that he considers himself to be still so much bound up with the interests of the concern, that he felt justified in acting as chairman of the meeting. Now this move did him credit, that is, in a Machiavellian sense, for it enabled him to make statements which were fairly safe to be uncontradicted; presiding over the meeting gave him power to quell the turbulent feelings of his auditors. The rôle of the injured person was adopted with some success; were it not that he did protest too much, he might have convinced the public that he was more sinned against than sinning. We are not going to much trouble to travesty the statements made, but we will point out that Mr. Harness says, "the only fault that was found with him was, that he was not a qualified electrician." It is not because he had not the necessary qualifications, but that he posed as the "eminent medical electrician" (*vide* pamphlets), when he had not the most elementary knowledge of electrical matters; it is not ignorance, but pretence, at which we have levelled our shafts of criticism. Another point which Mr. Harness, with singular adroitness, turned to advantage, was that "the business was now being conducted under the order of the Court of Chancery, which gave some idea that it was not the fraudulent company it was described by the *Pall Mall*." No doubt this may be considered a logical conclusion, and so it is, until it is pointed out that the Court of Chancery appointed an Official Receiver to protect the property of the debenture-holders, and not to carry on the business of the Medical Battery Company. If the Official Receiver were to carry on the business he would be a manager, and the counsel who asked for the appointment distinctly stated that, having regard to the nature of the business, he would not ask the Court to sanction the appointment of a manager. The rest we will leave to our readers.

The CHAIRMAN then stated that an attack had been made upon the institution by a small body of persons. It had been insidious and constant, and it caused a considerable damage to the company, but they were steadily recovering from it when the further attack of the *Pall Mall Gazette* was made. Why, he did not know, but it would be found out in the Law Courts. The result of the attack was that a writ was issued against the company, the debenture holders had taken possession, and Mr. Davies had been appointed as receiver. The business was now being conducted under the order of the Court of Chancery, which gave some idea that it was not the fraudulent company it was described by the *Pall Mall*. Answering several creditors, the chairman said the business had been a rich one from the beginning. The liabilities were about £14,000, and the assets, as a going concern, were valued at £60,000 or £70,000. He was sure that the people who had known the procedure of the business for the last 13 years would agree that they had worked very hard, and had got a princely business together, which had been pulled down by a few dissatisfied persons. The only fault that was found with him was that he was not a qualified electrician; but he had never represented himself as such, and he thought that with a reorganised scheme they could keep the business together, and the shareholders might get something as well. He thought they ought to be in a position to go to the Court and say that the company should be conducted as now, under the supervision of the Court, instead of by compulsory liquidation. Answering further questions, the Chairman believed the business had been injured 75 per cent. by the recent attacks. The people who had organised them had done it in a most unbusiness-like and un-English manner. He described the attacks as most cruel, for copies containing the articles had been sent nearly all over the world. The action against the *Pall Mall Gazette* would be fought to the death, and he stated that he had every reason to believe that he would get substantial damages. He defied the proprietors of the paper to prove a single statement they had made. In reply to a creditor, Mr. Harness added that if they decided upon voluntary liquidation, he would continue as managing director, and that without remuneration.

Eventually a resolution was moved authorising the winding-up to be conducted under the supervision of the Court, and not compulsorily.

Mr. LISLE next moved, and Mr. BANES seconded, a resolution to the effect that a committee of six creditors should be appointed, and obtain an expert to advise them.

A long and rather acrimonious discussion followed. Several creditors moved other amendments, while the chairman appealed to the meeting to conduct the proceedings in an orderly manner. In the midst of the scene a creditor shouted: "I move that the company be wound up compulsorily." (Cries of "No, no," and interruption.)

The CHAIRMAN protested against this wrangling, and pointed out that all he wished to do was to prevent the assets of "this princely business" from being destroyed by a few interested persons.

After much discussion, the proposal for the compulsory winding-up was put to the meeting, and lost by a large majority amid cheers and laughter. The original motion for winding-up under the supervision of the Court was carried. Some interruption again took place, several creditors declaring that the chairman had not acted fairly, but Mr. Harness strongly defended his action, declaring that his only object was to act perfectly fair to all concerned.

Mr. LISLE moved, and it was seconded, that a committee of six gentlemen be appointed to represent the creditors at the Courts.

After further acrimonious discussion, the chairman declared the resolution lost, but Mr. Lisle insisted upon a count, and eventually it was found that the motion had been carried.

NOTES.

Non-Synchronous Motors.—Rather an important paper was given in the *Elek. Zeit.* for September 8th, upon non-synchronous alternating current motors, by Dr. Behn-Eschenburg, including a theoretical discussion, with some practical conclusions. An abstract will be found in the "Digest" of the N.Y. *Electrical World* for October 14th.

Telephone Diaphragms.—The investigation of the extent of the excursion of the diaphragm of a telephone receiver under varying conditions of magnetising force, &c., has been for a long time occupying the students of the Rogers Laboratory of Physics. The *Proceedings* of the American Academy, No. xvi., contains an account of the later experiments of Messrs. Charles R. Cross and Henry M. Phillips in this direction.

Metropolitan Electric Supply Company.—From the directors' circular, published in our City Notes columns, it will be seen that this company has been making very satisfactory progress since the last meeting of shareholders. During the 12 months ended November, 1893, there have been 42,900 additional lamps connected to the mains. 19,797 of these were added during the first six months, and 23,103 during the latter six months of the period referred to. No actual figures are given as to the revenue, but the directors state that this has increased very satisfactorily.

The Institution of Civil Engineers.—At the opening meeting of the session 1893-94 of this institution, to be held on Tuesday, the 14th inst., the president, Mr. Alfred Giles, will deliver his inaugural address, after which he will present the medals and premiums awarded to the authors of several papers dealt with during the previous session.

Wilkinson v. Medical Battery Company, Limited.—In the Chancery Division of the High Court of Justice, on Saturday, the 4th inst., this matter came before Mr. Justice North.—Mr. Tanner said that the case came before his Lordship on motion for judgment on agreed minutes. The action was by the plaintiff, on behalf of herself and all other debenture holders of the defendant company, to enforce their securities. Under the terms of the debentures, which charged all the property of the company, the principal money became immediately payable on a meeting of the company being called to consider the desirability of winding up. Such a meeting had been called, and he believed that a resolution was passed to wind up voluntarily on the previous day. Under these circumstances minutes had been agreed, in the terms of which it was proposed to take judgment. —Mr. Henderson appeared for the company and consented. —Mr. Justice North having inspected the debentures, made an order in the terms of the agreed minutes.

Coast Communication.—Electrical Communication with Lightships.—Two vessels are being prepared, under the direction of the Trinity House, to relieve the lightships at the North Goodwin Sands and the Kentish Knock. The new ships are being built under contract, and they embody many improvements upon the lightships of older type, each being supplied with powerful syrens, the one for the North Goodwins being worked by steam, and that for the Kentish Knock by a carolic engine. The *Times* states that both vessels will be in direct electrical communication with the shore, the cable from the North Sands having its land connection at Dumpton Gap, and that from the Kentish Knock at Kingsgate Bay. The Post Office authorities will lay the cables, and the cost of the work and maintenance charges will be defrayed out of monies specially voted for the purpose by Parliament. For nearly 20 years the Goodwins have been protected by four lightships, in addition to intermediate nun buoys. The vessel at the North Sand Head is the oldest, having been established exactly 100 years; the Gull lightship took up its position in 1809; the lightship at the South Sand Head was moored there in 1832, and the one on the easterly side of the bank in 1874, the number of wrecks diminishing as each additional light was brought into use.

Municipal Management.—Municipal bodies have always been more or less conspicuous for peculiar ideas in matters involving technicalities. Their general business management frequently reveals defective points, but in things technical they have become a peculiar people. We have more than once referred to the silly quibbling and indulgence in personalities that are allowed to take place in what should be serious and disinterested discussions on electric lighting questions, particularly as in the cases of Taunton and Worcester; we have also previously spoken of the unjust manner in which contractors were treated regarding the tenders recently invited in connection with the lighting of Cardiff, and the curious way the Morley authorities set to work to obtain suitable electric lighting schemes by offering a tempting premium under the most ridiculous conditions. These are all instances of the necessity that exists for some improving element in methods of dealing with electric lighting municipally. But the case more especially before us at the moment is in connection with the Manchester installation. Although the work in connection with this station has been carried out in the most praiseworthy manner, the Corporation of that town have published regulations regarding the insulation resistance for premises to be fitted with the electric light, which are, perhaps, open to question; they are as follows:—

25 lamps	... ...	1 megohm.
50 „	... ...	750,000 ohms.
100 „	... ...	600,000 „
500 „	... ...	500,000 „

This compared with any other supply rules or regulations is entirely at variance with the general practice, and, as will be observed by our readers, gives no ratio of proportion at all.

Alternating Current Arcs.—*La Lumière Electrique* is giving a series of articles upon various experiments with alternating current arcs, written by M. Blondel. They will be found very valuable to those interested in the question.

A Disclaimer.—We are asked to state with reference to the slander case, Newman *v.* Hall, that neither Mr. L. S. M. Pyke nor Mr. Edward S. Harris, of Pyke, Harris & Company, Limited, have any knowledge of, or connection with, the Mr. Pyke or Mr. Harris therein mentioned.

The "Dicykel."—An apparatus for illustrating the laws of induction for lecture purposes has been called in Germany a "Dicykel." The *Electrical World* "Digest" describes it as consisting of two pointers, one showing the inducing current and the other the induced. When one moves to the right the other moves to the left, and *vice versâ*, while if the first shows a continuous current, the second will point to zero.

Personal.—Mr. W. F. Taylor, consulting electrical engineer, of Boswell Court, Croydon, was elected to the County Council of the Borough of Croydon, on the 1st inst.

Aberdeen Town Council.—It has been resolved to erect nine arc lamps in Castle Street and Union Street (as far as Union Bridge), and one lamp in St. Nicholas Street at the junction of Correction Wynd. The cost of the scheme, including pillars, lamps, and erection, would be about £252 10s., and the cost of maintenance and current per lamp about 2¼d. per hour.

Electric Light in Copenhagen.—The sale of electric current from the Copenhagen central station, through meters, amounted during the last six months of 1892 to 163,907,300 watt-hours, and during the first six months of the present year to 144,828,600 watt-hours. *Engineering* says that on January 1st, 1893, there were installed about 14,800 lamps of 16 candle-power, which number, during the first half of the present year, had risen to about 16,000 lamps. The consumption during the first half of 1893 was not so large as calculated.

Lectures.—The first of a course of six weekly lectures upon "Fire Risks of Electric Lighting," was given at the Municipal School of Electrical Engineering, Whitworth Street, Manchester, by Mr. Haldane Gee, the chief lecturer, to a large gathering of the members, on Tuesday night last week. Papers are to be given during the session upon "American Life Offices," "The Erratic Rating of Fire Risks," "Construction of Buildings," and "Tariffs."

Prof. Silvanus P. Thompson lectured at the Victoria Rooms, Bristol, on Wednesday, on "Supply and Measurement of Electricity."

Dublin Electric Lighting.—Extensions are to be carried out at Dublin; £24,400 is to be borrowed for this purpose. The normal capacity of the private lighting plant is now equal to the supply of 5,000 16-candle-power lamps, with a complete set in reserve; and the number of lamps now connected was 6,500. In addition to that they have demands from private consumers to the extent of 2,880 lamps. It was now proposed to extend the public lighting to districts including Stephen's Green, Dawson Street, Nassau Street, Leinster Street, Clare Street, Merrion Square North, part of Merrion Square West, Capel Street, Mary's Lane, and a number of other streets.

What's the Difference?—The London correspondent of the *Allahabad Pioneer* has made a very funny mistake; one which, were it a printer's or writer's error, we should have thought an ordinary proof-reader would have detected. He quotes a note that was recently published in the ELECTRICAL REVIEW, the purport of which was that the discovery had been made that sound was produced by a beam of light. This is how one sentence is given by our contemporary; we italicise the erratic word, which, needless to remark, should be *prism*:—"A beam of sunlight is caused to pass through a *prison* so as to produce what is called the solar spectrum, or rainbow." The *Madras Times* has likewise fallen into the same error in reproducing the note.

Clay Cross and Electric Lighting.—Rumour has it that some of the tradespeople are considering among themselves the electric lighting question.

Dr. Tibbits.—The name of Dr. Tibbits has been removed from the list of Fellows of the Royal College of Physicians of Edinburgh for unprofessional conduct. The name of Dr. Tibbits will be remembered as the plaintiff in the first of the Harness actions against the proprietors of the ELECTRICAL REVIEW.

Lighting the Lord Mayor's Carriage.—Lord Mayor Tyler has had the interior of his dress coach, which has been built by Messrs. Slatter & Son, of Long Acre, fitted up with electric batteries and lamps.

Bad Gas at Sale.—Dissatisfaction is expressed at the exceedingly bad quality of gas supplied at Sale. A correspondent of one of the Manchester papers exhorts the Local Board "boldly" to go in for the electric light.

Accident.—On Thursday last week a horse and trap collided with one of the Roundhay electric cars at Leeds, the horse being affrighted at the sight of the car. One of the occupants of the trap was severely cut and injured.

Lightning Express Railway Service.—Our readers may be interested to know that Mr. F. B. Behr has just entered into a contract with the Thames Ironworks and Shipbuilding Company, Limited, for making experiments on a large scale to perfect his system of Lightning Express Railways, especially with regard to the electrical details thereof.

Portraiture.—*Machinery Market*, a journal which makes a prominent and regular feature of publishing the portraits and business biographies of successful men of every department of the machinery world, in the November number makes Mr. Wilson Hartnell, of Leeds, the subject of its laudatory comments. In the litho photograph of that gentleman, our contemporary has been successful in securing what we consider a most accurate portrait.

The Chloride Electrical Storage Battery.—The discussion on Mr. Herbert Lloyd's paper, to which we referred in a recent issue, does not call for much comment. We would merely take objection to Mr. Lloyd's assertion that the *amount* of work done by batteries is the all important item. The *time* a battery has been in use, especially when rests of shorter or longer duration occur, should also be taken into consideration.

Society of Arts.—The first meeting of the forthcoming session is to be held on 15th inst. The following are among the papers to be read after Christmas:—"Automatic Balance of Reciprocating Machinery, and the Prevention of Vibration," by W. Worby Beaumont. "The St. Pancras Electric Light Installation," by Prof. Henry Robinson, M.Inst.C.E. "Electric Signalling without Wires," by William Henry Preece, F.R.S.

The Telephone Tubes in the City.—We have more than once referred to the course adopted by the City of London Electric Lighting Company, with a view to increasing their revenue and improving the telephone system of the City, by laying down telephone tubes along with the electric lighting mains, and so preventing the inconvenience to the public and the expense that would be incurred by a second opening up of the streets. The Commissioners of Sewers have had several discussions on the subject, and the Streets Committee have now issued a report which contains a copy of a letter received from the City of London Company regarding the laying of these tubes. They state that, except for purposes of their own, "the tubes were not being used for telephone purposes." Probably they are not *yet* being utilised for any other purposes, but, if we remember rightly, Sir David Salomons's remarks at the last meeting of the company were distinctly to the effect that they intended, after having obtained permission of three London authoritative bodies, to *let out* those tubes for the improvement of the City telephone system. He stated that the shareholders would *indirectly* benefit in regard to dividends, once the tubes were allowed to be used.

Institution of Electrical Engineers' Annual Dinner.—Amongst the invited guests who have accepted the invitation of the President and Council, are the President of the Board of Trade; the Postmaster-General; Sir Thomas Blomefield, Bart.; the Presidents of the Institutions of Civil Engineers, Mechanical Engineers, Iron and Steel Institute, the Chemical Society, and the Physical Society; the Astronomer Royal; the Hydrographer to the Admiralty; Sir James Crichton Browne; Sir Frederick Bramwell, Bart.; Sir Robert Rawlinson, K.C.B.

Partnership.—We understand that the old established firms of Theiler & Sons, of Canonbury, and Messrs. Elliott Bros., of St. Martin's Lane, are about to amalgamate, under the title of Messrs. Elliott Bros. Messrs. Theiler & Sons, who were established in 1857, are well known in the telegraph profession as one of the oldest telegraph firms in existence, and the disappearance of the old historic name is a subject for much regret; at the same time it should be mentioned that the firm of Elliott Bros. is of still greater antiquity, having been established as long ago as the year 1800, so that a few more years will see the completion of the century of its existence. The combination of two such firms is likely to prove an effective arrangement for the carrying on of the various classes of business of which they are representatives. Mr. G. K. B. Elphinstone, the able representative of Theiler & Sons, and Mr. W. Smith (son of the late Mr. Willoughby Smith), the no less able head of Messrs. Elliott Bros., will act as co-partners.

NEW COMPANY REGISTERED.

Lee Lamp (Parent) Company, Limited (39,850).—This company was registered on the 2nd inst. with a capital of £50,000, in £1 shares, to carry on in all its branches the business of manufacturers of and traders in lamps, and all parts of lamps, for lighting, heating, or other purposes, by the agency of oil, gas, electricity, or any other means; and to enter into an agreement made between J. H. Lee and J. Goodman. The subscribers are (with one share each):—C. Fitzroy H. H. Bagot, 59, Cadogan Square, S.W., gentleman; W. J. W. Chetwynd, The Cedars, Maidenhead, gentleman; C. M. E. Wynne, 22, Ryder Street, S.W., gentleman; Thomas Kaye, 11, Whittington Road, Peckham, gentleman; R. P. Lee, 30, Russell Road, N., solicitor's clerk; T. J. Crawley, 26, Munster Square, N.W., clerk; J. Goodman, 18, Lowmann, Road, N., gentleman. The first directors are:—The Hon. H. W. Chetwynd, R.N., Captain A. H. L. Bagot, B. Hodge, Captain A. E. Whitaker, and C. M. E. Wynne. Qualification, £100; remuneration, £150 per annum for the chairman, and £100 a year to each director, together with percentage on profits. Registered by Wynne and Son, 31, Lincoln's Inn Fields, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Ozone Syndicate, Limited.—The statutory return of this concern states that the nominal capital is £25,000, in £5 shares, and that out of this seven shares only have been taken up. There has been nothing paid.

Single Wire Multiple Telephone Signal Company, Limited.—The annual return of this company, made up to last August, shows that out of a nominal capital of £5,000, in £10 shares, 254 shares have been taken up, with the full amount called on each. The whole sum has been paid.

Portland Electric Light Company, Limited.—Messrs. Strode & Co., of 48, Osnaburgh Street, Regent's Park, have written to the Registrar of Joint Stock Companies, Somerset House, stating that the Portland Electric Light Company is not carrying on business.

The St. Martin's Electrical Manufacturing Company, Limited.—The registered office of this company is now at 3, Peter's Court, St. Martin's Lane, W.C.

CONTRACTS CLOSED.

Londonderry Electric Lighting.—The Corporation have authorised Messrs. Alexander Brown & Son, of Derry, to erect 100 ornamental pillars, at £9 each, for the electric lighting of the town. £100 is to be paid to the proprietors of Sun Foundry (Messrs. Geo. Smith & Son) as a royalty, or for permission to cast the same. The Corporation will pay the money and deduct it from Messrs. Brown's bill.

Hull.—Mr. Joseph Edmondson, of the Albert Electrical Works, Bradford, has secured the order for two 750 ampère O. E. meters for registering the total outputs of the Hull electric lighting stations. They are to be coupled on to the two outside conductors of the three-wire system.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's), now under the direct supervision of the proprietors, H. Alabaster, Gatehouse & Co., is in active preparation for the 1894 edition (13th year). This is a directory of the electrical trades embracing the whole Universe, and having no superfluous matter irrelevant to a directory it can be sent everywhere, carriage paid, for 4s. It is indispensable to all having business transactions in the electrical world, and once used cannot be done without. Advertise in it! Order it! It will prove the best outlay ever made.

Bankruptcy.—William Andrews, electrician, came up for examination at Nottingham courts last week. He lately carried on business at 118, Hunger Hill Road. Liabilities amounted to £495 18s. 10d., and assets £423 8s. He started business as an electrician 17 years ago, on the Hunger Hill Road, with £20, which he had borrowed from his wife. In 1889 and 1890 he took out patents for improvements in railway signalling apparatus. Finally, he sold a moiety of his interest in the first patent and the whole of his interest in the second, to the Railway Electrical Fog Signalling Syndicate, Limited. There were 18,000 shares of £1 each. Four thousand of the shares were allotted to Mr. Hooley in respect of the interest in the patents which he had obtained by previous purchase from debtor, and 10,000 more to Mr. Morley in similar circumstances, leaving 4,000 shares, which was the consideration for which he (debtor) made the sale. He was sure he did not suppress any of the particulars of any previous sales of interests in the payment from the syndicate. He had sold over 3,000 of the shares, but had kept no account of the sales, nor of the money he received for them. He gave 750 shares as qualifications for the directors, although no stipulation had been made to this effect in the agreement. He had expected to be able to regain his position by the development of his signal patent. Altogether he had received £910 for sales of interests in the two patents before the sale to the syndicate, and this had been expended in the development of the patents, and the money he had received from the sale of his 3,000 shares was similarly spent. He hoped to have a claim from the syndicate for the money he had spent in furthering the patent, although there was no agreement to this effect. The Registrar adjourned the examination to the next court, in December, ordering that the debtor should supply, as far as possible, an account of the money which had been expended during the past twelve months in connection with the patents.

At the Leeds Bankruptcy Court last week an application was made to Mr. Registrar Giffard for an order of discharge on behalf of Henry Bury, electrical engineer, formerly carrying on business at Bury New Road, and Arcade Chambers, Manchester, and recently residing at 12, Dacre Street, Westminster. Mr. Egerton S. Grey, assistant receiver, reported that the failure occurred in December last, the accounts showing total liabilities £509, of which £328 was expected to rank against assets £44 16s. The bankrupt attributed his failure to legal costs and expenses incurred in an action defended by him in respect of an alleged defective motor which he purchased, also to liabilities incurred in connection with accommodation bill transactions. The offences charged by the official receiver were (1) that the assets are not equal to 10s. in the £ on the unsecured debts; (2) a previous composition arrangement with the creditors; (3) contributing to the bankruptcy by a rash and hazardous speculation; and (4) contracting debts provable in bankruptcy without having any reasonable or probable ground of expectation of being able to pay them. After hearing Mr. Phillips in support of the application, the learned registrar held that the charges of rash and hazardous speculation, and of contracting debts without reasonable expectation of being able to pay them, had not been proved. On the ground of the remaining offences, he suspended the discharge for two years. Order entered accordingly.

An Electrical Patent Case.—In the Queen's Bench Division, on Monday, before Mr. Justice Cave, sitting without a jury, Mr. Edward Hutchinson Pollard, barrister-at-law, brought an action against Mr. Arthur Rust to recover damages for breach of an agreement, or, in the alternative, £1,333 6s. 8d. as a bonus which he alleged was due to him. From the statement of counsel it appeared that defendant made advances to Mr. Charles Langdon Davies, an electrician, for the purpose of working patents, the object of which was to utilise telegraph wires for the purposes of telephone work. Plaintiff stated that in consideration of his guaranteeing the advances made by Rust to Davies, he was to have two-thirds of a bonus of £2,000 which he was to receive from Davies. Later on it appeared that Rust entered into a new agreement with Davies, and purchased half his patent rights for £5,000 and gave him a release in regard to his advances. Ultimately judgment was given for the plaintiff for £666 13s. 4d.

Primrose Day Decorations.—On Wednesday, in the Westminster County Court, Judge Lumley Smith, Q.C., had before him the case of the "Electrical Installation Company *v.* Juliet," which was a claim by the plaintiffs for out of pocket expenses in connection with the hire of lamps, wire, &c., in connection with an order from Madame Juliet, of Albemarle Street, for the illumination of the Beaconsfield statue in Parliament Square on Primrose Day last. Mr. Marriott, solicitor, appeared for the company. Mrs. Norton, the defendant's manageress, represented the defendant. John G. O'Brien, the plaintiffs' manager, said his firm gave an estimate for illuminating the Beaconsfield statue with incandescent lights to Madame Juliet, a florist, of Albemarle Street, who said she had an order to do it from the Primrose League. They got batteries, &c., from the Electrical Storage Company, and paid £1 7s. 6d. for the hire of them, but when they went to Parliament Square they were not allowed to operate on the statue, as they could show the police no authority. Mrs. Norton said that Madame Juliet was ordered by Mr. George Lane-Fox to do these illuminations. The contract was never carried out, and the defendant did not see why she should pay. His Honour: The plaintiff received an order from you, and would have carried it out. It was not his fault. You must get your money back from Mr. Lane-Fox. The plaintiffs' claim has been made out to the extent of £1 17s. 9d., and they must have judgment for that amount, with costs.

One of the Results of the Coal Strike.—The City of London Electric Light Company, Limited, were summoned at Southwark on Wednesday by Inspector Grist, representing the St. Saviour's District Board of Works, Southwark, for an infringement of the Smoke Nuisance Abatement Act by allowing black smoke to issue from their premises at Bank Side on several days during the month of October. Mr. Dewdney said the company did not dispute the facts, but wished the magistrate to take into consideration the circumstances under which the cause of complaint had arisen. In consequence of the coal strike, they were unable to obtain a supply of Welsh smokeless coal for which they had contracted, although they had offered 10s. per ton more than the contract price. In consequence of this they tried to keep their works going by burning coke at considerable inconvenience and increased cost, but after a short time the coke supply also failed, and they were left on the horns of this dilemma: either they must stop their works, which it was impossible for them to do without breaking their contract for the electric lighting of the City, or use other coal, which they could not burn without subjecting themselves to the penalties for which they were now sued. Their difficulty was now at an end, and for the last week or two Welsh coal had again been obtained, and the company hoped to be in a position to give no further cause of complaint. The case was adjourned for four weeks in order to see whether the nuisance had been abated.

Electric Cooking.—The General Electric Company, Limited, have lately been giving much attention to electric heating and cooking. We referred more particularly to their accomplishments in this direction a few weeks ago. The firm have now published a price list in pamphlet form (Section H.), the chief feature being electric heating and cooking. The introductory remarks deal exclusively with this comparatively recent branch of the industry; they set forth in very simple language the numerous advantages claimed for the electrical system of cooking over other methods, some figures are also given regarding efficiency of the apparatus shown. The articles described are illustrated by some excellent blocks, mostly drawn to scale; there are electric cooking kettles, coffee machines, stew-pans, frying pans, saucepans, steam cookers, ovens, a variety of irons, grillers, hot plates, and warming stoves. The last few pages of the book are devoted to cigar lighters, shaving pots, glue pots, curling iron heater, portable lamps, step-up transformers, and several other items, including electric pianos. Everything pertaining to this new system of cooking is of interest, but the catalogue of the General Electric Company is exceedingly so, and is well worthy of our readers' perusal.

Mill Lighting.—Rock Mill, Waterloo, has lately been lighted throughout by electricity by Messrs. J. H. Holmes & Co., of Newcastle. The installation consists of two dynamos, the larger of which is capable of supplying the whole of the light in the mill; the other is a pilot dynamo for 150 lights for use when the main engine is stopped. The output of the large dynamo is equivalent to lighting 770 lamps. This dynamo was tested for five hours continuously with a load of 55,000 volts, equal to 920 and 16 C.P. lamps, that is 20 per cent. in excess of its usual load, with the satisfactory result that all parts of the machine kept perfectly cool. The larger dynamo is driven by belt from a countershaft driven by the mill engine. The pilot dynamo is driven by ropes from the fly-wheel of a special engine erected by Messrs. Holmes, having an 8-inch cylinder and a stroke of 12 inches. This machine is capable of supplying 150 lamps. The work has been carried out under the superintendence of Mr. Broadbent.

Pumping by Electricity.—A great deal of work has been executed lately in this branch of the electrical industry by Messrs. Ernest Scott & Mountain. We understand that immediate contracts in hand represent three sets of electrical pumping plant for the Lothian Coal Company equal to a total delivery of 600 gallons of water per minute against a head of 600 feet. Also a complete set of similar plant for the Coltness Iron Company, to deliver 150 gallons of water per minute against a head of 130 feet; and they have, further, to supply a set for South Africa to deliver 200 gallons per minute against a head of 150 feet. The plants have all to be complete with the necessary accessorial electrical machinery. The North Seaton, Newton and Shilbottle collieries plants we have already referred to. The North Seaton plant, which is said to be one of the largest in the kingdom, has been running for the last 12 to 15 months on an average of 22 hours per day, without any stoppage of the machinery.

Tunbridge Wells Electric Lighting.—A Local Government inquiry was held last week in regard to the application by the Corporation for a loan of £13,000 for the purpose of lighting the borough by electricity. The Town Clerk stated that the rateable value of Tunbridge Wells was £208,000, the approximate debt of the borough £280,000. Some years ago, several private companies proposed to introduce the electric light into the borough, and finding this to be the case the matter was taken up by the Town Council. An expert, Mr. A. H. Preece, had reported that there were 40,000 gas lamps and lights in the borough. They did not, however, propose to go in for the entire substitution of electricity for gas, but only deal with a portion of the borough by way of experiment; and if, as was hoped, it was a success the question of lighting the whole of the town would be considered. They had secured an admirable site for the electric light premises, viz., near the Grosvenor Bridge, close to the South Eastern Railway. Mr. A. H. Preece, described, by means of maps and diagrams, his proposals. He stated that the high-pressure current system would be adopted, and the mains laid underground. All the accessories at the engine-house would be arranged in duplicate. He thought the amount asked for would cover the initial expenses for the plant and installations. There was a little opposition to the scheme.

Wolverhampton and Electric Lighting.—The Town Council will shortly be applying for sanction to borrow money for electric lighting, refuse destructors and other purposes. The question of providing the electric light for the borough is being dealt with by the Lighting Committee, and after referring to the appointment of Mr. F. H. Lewis as electrical engineer and architect for the building of the central station, the reports of that Committee states that plans and specifications are being prepared, and the engineer is negotiating with the Electric Construction Company, with a view of obtaining a modified tender from them for the plant and machinery necessary to supply electricity for 5,000 incandescent lamps and forty arc lamps for street lighting, also with Mr. John Thompson for boilers, and Messrs. Callender & Co. for the laying of cables, &c. The architect is also preparing plans for the buildings.

Stafford Electric Lighting.—At a meeting of the General Purposes Committee, on September 15th, Mr. Hare informed the committee that time being of importance, and the matter special, he had requested Messrs. Kincaid & Co., of 29, Great George Street, Westminster, to prepare the necessary specifications for obtaining tenders for wiring certain buildings and submitted the tenders received. It was resolved that the tender of Messrs. Rooper and Tozer for £450 be accepted, and that the council be recommended to affix the seal to the necessary contract when approved by the clerk, and that the council be recommended to sanction the payment to Messrs. Kincaid & Co. of their fee of £52 10s. when the works are completed to the satisfaction of the architect, the amount to be debited to the cost of electric lighting.

Almondbank Electric Lighting.—Messrs. Lumsden and MacKenzie have resolved to light up their extensive works at Huntingtowerfield by electricity, the carrying out of the work being entrusted to Messrs. Lowden Brothers, Dundee, who have just about completed their contract. The plant supplied and fitted up consists of a double diagonal engine, 10-inch cylinders, 12-inch stroke, driving a Manchester dynamo, giving 180 ampères at 100 volts pressure, and supplying current for over 100 incandescent lamps, ranging from 16 to 200 candle-power each, and also for a battery of 54-17 K type accumulator cells, storing current for over 70 incandescent lamps, each of 16 candle-power, which are in the mansion Mr. Lumsden has lately had erected.

Lighting Glasgow Tramcars by Electricity.—The minutes of the Gas and Electric Lighting Committee stated that at a meeting on October 11th, Mr. Arnot, the electrical engineer, as instructed at last meeting, submitted the statement of cost which he was then instructed to prepare. The joint sub-committees, having considered the statement, were unanimously of opinion that, in the whole circumstances, it will be more convenient and expedient to make arrangements for charging the accumulators required for lighting the cars at one or more of the car depôts now being erected by the corporation instead of getting this done at the existing central electric lighting station in Waterloo Street. This has been agreed to by the corporation.

Telescopic Platform Ladders.—Messrs. Heathman and Co., have supplied several patent telescopic ladders for use at the Liverpool Street and Bishopsgate stations of the Great Eastern Railway Company, to the order of Messrs. Crompton & Co., who are carrying out the electric light installations for that company. These ladders were described in our columns a few weeks ago. Messrs. Heathman have just delivered one of these platform ladders to the new municipal building at Battersea, to reach lamps 40 feet high and yet pass through 6 feet 9 inch high doorways, while they are now building one for 26 feet lamps and mounted on high wheels for one man to drag about the public roadways at Kingston-on-Thames.

The Electric Lighting of Rugby School.—Messrs. Pyke, Harris & Co., Limited, have recently fulfilled with their inductor alternator a unique requirement. Mr. J. A. McMullen, consulting engineer to Rugby School, required an alternator of no larger than 6 kilowatt capacity, which should be capable of furnishing current at an E.M.F. as great as 2,000 volts. This requirement was satisfactorily performed, and at the delivery test, the machine ran quite satisfactorily with full load for four hours without the least sign of heating. This speaks well for the future of inductor alternators. The machine is only 20 inches long by 15 inches wide by 21 inches high.

Electric Lighting in the City.—At a meeting of the Commission of Sewers on Tuesday last, Mr. Johnston moved that Crutched Friars be lighted by electricity. He said that although Crutched Friars was not scheduled for the light, its importance as a thoroughfare and its busy traffic made it imperative that it should be efficiently lighted. Mr. C. T. Harris contended that the Commission should pause before they incurred further expense in electric lighting. The bill for lighting the whole of the City by gas was £5,530 per annum. The cost of lighting by electricity the eastern district of the City alone was £6,000, and when £500 was added for the maintenance of the present gas standards they would see that one district alone cost £1,000 more for electricity than the whole of the three districts did when lighted by gas. As a matter of fact, the cost of gas for the eastern district was only £1,500, while electricity for the same area cost three and a half times as much. After some discussion it was decided to refer the proposal to the Streets Committee for consideration.

The Empire Palace, Bristol.—Messrs. Vaughan and Brown, of London, have just installed the electric light throughout the whole of this building. They have made and fixed massive egg-shaped lanterns in brass and glass for the main auditorium ceiling, elegant three-arm brackets in ornamental polished brass, and coloured glass round the gallery and balcony fronts, also massive electroliers and standards in the stalls, balcony, bars, and front entrances. This firm have also installed the gas all over the building, and fixed in the main ceiling, with ventilating shafts, one of their large patent sun burners. They have carried out the whole of the work in four weeks, under the supervision of the architects Messrs. Wylson & Long.

The Pioneer Telephone Company, Limited.—A general meeting of this company is to be held at 1 and 2, Great Winchester Street, E.C., on December 4th, 1893, at three o'clock, for the purpose of having an account laid before the members, showing the manner in which the winding up has been conducted, and the property of the company disposed of, and of hearing any explanation that may be given by the liquidators; and also of determining, by extraordinary resolution, the manner in which the books, accounts, and documents of the company, and of the liquidators thereof, shall be disposed of.

Hospital Lighting.—The Stratford Infectious Diseases Hospital has been lighted by electricity. For lighting the whole of the hospital buildings 32 incandescent lamps are used, also 12 similar lamps at the sewage works. The motive power is derived from the steam engine at the sewage works, with which is connected a four-horse Statter dynamo.

The new isolation hospital at East Ham has been lighted throughout by electricity, the power being derived from the Board's sewage works.

Electric Lighting at Glasgow.—At a meeting of the sub-committee on galleries on October 20th, a verbal report was made by the curator of the galleries as to the cost of lighting the Corporation Galleries by gas, and the report by Mr. Arnot as to the cost of lighting them by the electric light having been reconsidered, it was resolved to recommend that electricity should be adopted throughout the galleries, and that the Crompton lamp should be used. This has been resolved upon by the corporation.

The "Hard" Incandescent Lamps.—These lamps can now be had in London from the agents, Messrs. Wilhelm & Co., 132, Wool Exchange. The manufactory of the "Hard" Incandescent Lamp Company at Zurich is one of the few that have been specially fitted up for the making of incandescent lamps, and is superintended by English engineers whose experience dates from the commencement of the industry. The company base their claim to favour on the high quality of the lamps they turn out.

City of Winchester Electric Lighting.—At the last meeting of the Town Council a resolution was adopted confirming the award of Mr. Morgan Williams in the matter of the premium recently offered by the Corporation for the most suitable scheme for the lighting of the City. As the result of his exhaustive report on the whole of the schemes, the premium was awarded to the one submitted by the Brush Electrical Engineering Company.

New Journal.—A new fourpenny monthly paper known as the *Sanitary Officer*, has lately come into existence. It deals in a very interesting and readable manner with all subjects relating to the public health. No. 3 contains much pithy information, yet we must confess that, speaking as a whole, we think the journal has less reading than similar journals published at a more modest price.

Pocket Diary.—Messrs. Emmott & Co., of Manchester, have, in accordance with their usual custom during the past seven years, published the sixpenny *Mechanical World* Pocket Diary and Year Book for next year. The diary is of very convenient size, and contains much information of value to engineers, mechanics, and workmen engaged in kindred trades.

Price Lists.—From Messrs. O. Berend & Co., we have received a copy of their October trade price list of grease and oil lubricators, and a variety of oiling utensils. The Deuss automatic waste oil filters are described at the end of the book. There are a number of illustrations, and, on the whole, the pamphlet is a neat production.

The Telephone at Wrexham.—The National Telephone Company recently offered to the Corporation to provide a connection with the company's exchange in the Wrexham District, for one year free of all cost, to facilitate communication with the fire engine station. This offer has been accepted.

Colliery Lighting.—Messrs. Styrup & Pry have this week installed the electric light at their Alderley Green Colliery, Longton. The light at present is only on the pit bank. The whole of the work has been carried out by Messrs. Woodhouse & Rawson United, Limited.

Electric Light in Lancaster.—On the 1st inst., Market Square, Lancaster, was lighted for the first time with electricity. The work of laying electric cables in the various streets is proceeding rapidly, and it is expected to be completed by about Christmas.

Electric Lighting at Llanelly.—The members of the Llanelly Local Board last Friday paid a visit of inspection to the town of Pontypool, at the invitation of Mr. J. C. Howell, who has just completed an installation of electric light there.

Telegraphic Communication.—The Eastern Telegraph Company, Limited, announces that telegraphic communication has been established between the company's station at Lisbon and the islands of San Jorge, Pico, and Torceira.

The Direct Spanish Telegraph Company, Limited.—This company opened a branch office, for telegrams exchanged with Spain and their system, in the Foreign Auction Hall, Covent Garden Market on Monday last.

Belfast Electric Lighting.—Several of the principal specifications have been received by the Corporation from Professor Kennedy, and as soon as the remainder come to hand, tenders are to be advertised for.

Ravensthorpe and Electric Lighting.—Arrangements are in hand for lighting the Self-Help Stores by electricity.

Awards.—Doulton & Co. have obtained six highest awards for their various manufactures as exhibited at Chicago Exhibition.

CITY NOTES.

The West India and Panama Telegraph Company, Limited.

THE directors' report for the half-year ended June 30th, 1893, to be submitted to the thirty-third ordinary general meeting on 15th inst., reads as follows:—

"The directors submit the accounts for the six months ended June 30th, 1893. The amount to credit of revenue is £46,687 4s. 3d. against £44,148 17s. 7d. for the corresponding half-year of 1892, and the expenses for the same period have been £24,794 6s. 11d. against £28,589 6s. 4d., leaving a balance of £21,892 17s. 4d., which, with £1,430 3s. brought from last account, makes a total of £23,323 0s. 4d. Of this sum the directors have placed £3,000 to reserve, leaving an available balance of £20,323 0s. 4d., with which it is proposed to deal as follows:—First preference shares—Dividend, six months to June 30th, 6s. per share, £10,368 18s.; Second preference shares—Dividend, six months to June 30th, 6s. per share, £1,400 14s.; Ordinary shares —1s. per share (free of income tax), £4,416 1s.; balance to current half-year's account, £4,137 7s. 4d.; total, £20,323 0s. 4d. The traffic receipts for the six months show an increase of £4,170 13s. 4d. as compared with the corresponding period, this increase being largely due to an interruption of the French Company's cable to Haiti, which lasted about seven weeks, and diverted traffic to this company's line. It will be remembered that the traffic receipts for the first six months of the last year showed a decrease of £3,762, attributable to the reductions in tariff made the year before. If the exceptional revenue derived from the interruption above referred to is left out of account, the traffic proper of this company's system shows a decrease of £2,391, in comparison with the traffic prior to the reduction made in 1891. Since the close of the half-year the directors regret to have to report a further falling off of 15 per cent. in the estimated traffics up to date in comparison with the corresponding period of 1892. The expenses of repairs to cables amounted to £10,520 18s. 11d., being £12,358 1s. 11d. less than those for the corresponding period. This decrease is due to fewer repairs and to the smaller quantity of cable used. The company's repairing steamer *Duchess of Marlborough* has been brought home to be surveyed in accordance with Lloyd's requirements. She has, after the completion of certain repairs, passed her No. 2 survey, and is now in London ready to be commissioned when required. The directors have to report, with much sorrow, the death of another member of the board that was elected by the shareholders in 1874. Mr. Henry Weaver, whose name has been prominently connected with the telegraphic service of the country almost from its inception, died on September 20th last. His loss is deeply regretted by his colleagues. Under the powers given to them by the articles of association they have elected Mr. Gerald W. Balfour, M.P., to fill the vacancy thus created. The directors desiring to recognise the long and faithful services of some of the employés and to strengthen the good relations that exist between the company and its staff, propose to follow what has become a very general practice, and to offer to bear one-half the expense of life or endowment insurances for some of those who have been in the company's service a certain number of years. They trust that this measure will meet with the approval of the shareholders.

The Metropolitan Electric Supply Company, Limited.

THE directors have circulated among the shareholders the following account of the company's present position:—"In fulfilment of the desire expressed at the last annual general meeting that the shareholders should be informed as to the company's progress during the present year, the board have pleasure in stating that the increase of business is being satisfactorily maintained. The number of lamps connected to the company's system, which, in November, 1892, amounted to 114,656, and at the date of the general meeting in April last to 134,453, now amounts to 157,556, and additional applications are in hand for the supply of current to 7,557 lamps. The gross revenue for the six months ending June 30th, 1893, shows a very satisfactory advance upon that for the corresponding period of 1892, while the working expenses for the same period fully bear out the views which the board have frequently expressed as to the small additional cost of production as compared with the increased revenue earned. The gross revenue for the quarter ending September 30th shows that the rate of increase over 1892 continues. The patents relating to the manufacture of incandescent lamps expire on the 10th of the present month, and consequently great reductions in the prices of these lamps are in course of being made. While it is difficult to foresee all the results that may arise from a change of so much importance to consumers, there can be little doubt that this company must benefit by anything which tends to cheapen and popularise the use of the electric light. The board are so satisfied with the present progress of the company, that they have no doubt they will be in a position to recommend the payment of half-yearly dividends in future years."

Aluminium Company.

MR. GERALD W. BALFOUR, M.P., presided over the sixth annual ordinary general meeting of this company, held on 2nd inst. at the Cannon Street Hotel, E.C.

In moving the adoption of the report, the CHAIRMAN said it was with great pleasure that he was able to state that the company showed a trading profit of £7,000. But that was not all—the business had been, and was, a growing business. From July to October last year a loss was shown of £2,500; from November to June in the present year there was a profit of £10,000, and the output was two and a half times what it had been during the previous four months; for July, August, and September last the average daily output was three and one-third times as much, and the trading profit was at the rate of £20,000 a year, while during the last three months the average daily output had risen to four and a half times the amount, calculations on that basis showing that profits was being earned at the rate of £25,000 to £30,000 a year. In the course of the last few months a license had been granted to a German chemical firm to manufacture under the company's patent, the royalties going to increase the profits of the company. In the opinion of the directors, the time had now come to write down the nominal capital, the reasons that could be urged in favour of the measure being very convincing.

Sir H. E. ROSCOE, M.P., seconded the motion, which was adopted unanimously.

An extraordinary general meeting was then held, when a resolution reducing the capital from £400,000 to £80,000 was passed, with one dissentient.

Western and Brazilian Telegraph Company.

The directors' report for the half-year ended June 30th states that the total earnings amounted to £79,373, a decrease of £4,648, and the working expenses to £43,424, an increase of £4,283. It is explained that the expenses necessarily differ because of the extra staff and arrangements required to work the line completed in 1892. Including the amount brought forward (£2,829), the revenue balance is £38,779, from which have to be deducted £12,093 for debenture interest, and £7,007 for the debenture redemption fund, leaving £19,679, of which £12,000 has been placed to the reserve fund. This leaves £7,679 to be carried forward. We shall print the report in full next week.

Chatham Electric Lighting Company.

A MEETING of the shareholders in the above company was held at the Works, Whittaker Street, Chatham, on Wednesday last week, to consider the proposal of the directors for the issue of debenture shares to the value of £12,000. It was agreed, after prolonged discussion, that the meeting sanction the issue of £12,000 in debenture shares on the best terms that could be got, but only £4,000 was to be taken up before another meeting of the shareholders was called.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 5th, 1893, amounted to £871; week ending November 6th, 1892, £891; decrease £20; total receipts for half-year, 1893, £14,637; corresponding period, 1892, £14,400; increase £237.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of October, 1893, amounted to £2,121, against £2,307 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in October, 1893, were £23,200; January 1st to October 31st, 1893, £226,800; corresponding months, 1892, £223,000; corresponding months, 1891, £237,800.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 3rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,994.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, November 1st.	Closing Quotation November 8th.	Business done during week ended November 8th, 1893. Highest.	Lowest.
184,500£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 -103	100 —103	100¼	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	45 - 47	45 - 47	46½	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	83 - 85	84 — 85	84⅛	83⅝
2,932,680£	Do. do. Deferred	Stock	7⅜ - 8¼	7⅜— 8¼	8¼	8¼
130,000	Brazilian Submarine Telegraph, Limited	10	11⅞ - 12¼	11¾ - 12⅛	12⅛	11⅞
18,700£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	101¼	...
75,600£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ - 3	2⅞— 3	3	2⅞
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ - 2⅜	2⅛— 2⅜	2 5/16	2⅛
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	107 —109	106 —108	107½	106
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4⅜— 5⅛	4⅜— 5⅛	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	28 — 33	28 — 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11⅛— 11⅜	11⅛—11⅜	11 11/16	11⅛
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅜— 13⅛	12⅜— 13⅛	13	12⅜
10,000,000$	Commercial Cable, Capital Stock	$100	135 —140	140 —150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	10/-	1/16— 3/16	1/16— 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	3½ - 4⅛	4 — 4⅛	...	...
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11½ - 12½	11½ - 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2⅛ - 3⅛	2⅛ — 3⅛	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ - 9½	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅞ - 11⅛	11⅛ - 11⅜	11 3/16	11
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝ - 15	14⅝— 15	15⅛	14 13/16
70,000	Do. 6 p. c. Preference	10	15½ - 16½	15½— 16½	16 1/16	15⅝
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294 100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	113 —116 xd	113 —116 xd	115⅜	114
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15 3/16	15
62,700£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	103¼	102
222,800£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	103¼	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	113 —116	113 —116	115	...
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	102	101½
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	102¼	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	101⅛	...
200,000£	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	104 —107 %	103 —106 %	104¼	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	1⅞ - 2¼	1⅞— 2¼	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛— ¼	⅛— ¼	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛— ⅛	⅛— ⅛	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅛— ⅛	⅛— ⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	¼ - 1⅛	¼— 1⅛	...	...
180,227	Globe Telegraph and Trust, Limited	10	8⅜ - 8⅞	8⅛— 8⅜	8⅜	8⅛
160,042	Do. do. 6 p. c. Preference	10	14⅜ - 15	14⅜— 15	15	14⅜
150,000	Great Northern Tel. Company of Copenhagen	10	20 — 20½	20 — 20½	20½	20¼
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	103 —106	103 —106	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½— 22½	21½— 22½	22¼	21½
200,000£	Do. do. 4½ p. c., Deb., 1896	100	101 —103	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 43 xd	40 — 43 xd	42	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ - 4¾	4¼— 4¾	4 15/16	4 13/16
15,000	Do. do. fully paid	5	6 — 6¼	6 3/16— 6 7/16	6⅛	5¾
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	5⅛— 5⅜	5⅛— 5⅜	8¼	4⅜
6,295	Do. do. Pref., £6 paid	10	6 1/16— 6 3/16	6 1/16— 6 3/16	6⅛	...
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7½— 7⅝	7½— 8	8⅛	7 3/16
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	104 —107	104 —107	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1⅜— 2⅛	1⅜— 2⅛	...	...
‡28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5	4⅜— 5	4 15/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	13½— 14½	13½— 14½	14⅜	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½— 14½	13½— 14½	...	...
119,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5½— 5½	5½— 5½	...	...
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —115	113 —115	113⅞	113½
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	102 —105	102 —105	...	...
11,802	Reuter's Limited	8	5½— 6½	5½— 6½	...	...
19 980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6 — 6½	6 — 6½	6 7/8	6 3/4
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8 5/16	8⅛
3,381	Submarine Cables Trust	Cert.	113 —118	113 —118	116½	116½
78,942	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2 — 2½	2 — 2½	2⅜	2 1/16
37,350	Telegraph Construction and Maintenance, Limited	12	32 — 34	33 — 35	34½	32½
1 0,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
38,000	United River Plate Telephone, Limited	5	2 — 2½	2 — 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½— 6½	5½— 6½	...	...
260,900£	Do. do. 5 p. c. Debentures	100	98 —101	98 —101	...	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —103	99 —103	...	...
64,242	Western and Brazilian Telegraph, Limited	15	5½— 6½	5⅝— 6½	6	5⅝
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½— 5⅝	5½— 5½	5½	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1 — 1½	1 — 1½	...	...
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½— 1⅝	1⅝	1½
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10½	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 —10	9 — 10	9½	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	106 —109	107 —110	109	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	115 —120	113 —118 xd	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	102 —105	102 —105	...	...
69,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5 — 5⅛	5⅛— 6	5⅝	5 7/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 6—6½.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent premium, 100—103.—Electric Construction Corporation 6 per cent. Debentures, 96—98.—Electric and General Investment, shares of £5 (£1 paid), 1½—2½.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5—5½.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅝—5⅞, 1st Preference Cumulative 6 per cent., £5 (fully paid 6—6½.—Manchester, Edison and Swan Company £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating 6 per cent. £100 Debentures, 121—125.
Bank rate of discount, 3 per cent. (October 5th, 1893.)

PROCEEDINGS OF SOCIETIES.

Physical Society, October 27th, 1893.

Prof. J. PERRY, F.R.S., Vice-President, in the chair.

Mr. E. C. RIMINGTON read a paper ON THE BEHAVIOUR OF AN AIR-CORE TRANSFORMER WHEN THE FREQUENCY IS BELOW A CERTAIN CRITICAL VALUE.

Taking the ordinary differential equations for two circuits having self and mutual induction and assuming sinusoidal E.M.Fs. and constant coefficients, the author shows that although the difference of phase between the primary P.D. and primary current is always diminished on closing the secondary circuit, yet, under certain circumstances, this closing increases the impedance of the primary. With constant P.D. this means that closing the secondary decreases the primary current, a phenomenon not usually observed. The critical conditions necessary for increased impedance are fully worked out in the paper as well as those under which this increase becomes a maximum. In the case of two identical coils with no magnetic leakage, the critical value of α $\left(\alpha = \frac{p\,L}{r_1}\right.$, where $p = 2\pi$ times the frequency, L the inductance of the primary, and r_1 its resistance), is $\sqrt{2}$, whilst that to give maximum impedance is $\frac{1}{\sqrt{2}}$.

The maximum increase possible is 15½ per cent. The corresponding values are given for various amounts of magnetic leakage in tabular form, and curves were exhibited at the meeting showing how the impedance, current, power, and magnetising effect, vary for different values of α.

To test his conclusion, the author made experiments on two coils close together, the observed increase in impedance amounting to 3·2 per cent.

In addition to the analytical investigation, the subject is treated geometrically at considerable length.

Prof. MINCHIN showed that the impedances might be represented by two hyperbolas having p^2 as abscissæ and the squares of the impedances as ordinates. These could be readily constructed from the data given. A line representing the primary inductance drawn on the same diagram intersects one hyperbola, showing that the impedance has always a maximum value. By a simple construction the phase angle between the primary and secondary currents could be determined for any given conditions.

Dr. SUMPNER observed that increased impedance on closing the secondary necessarily meant a decrease in the lag of the primary current behind the primary P.D.

Mr. BLAKESLEY was pleased to see that the geometrical method was of such service and thought it much simpler than the analytical one. The reason why increased impedance on closing the secondary of ordinary transformers had not been noticed was because their lag angles were very large. In a figure published some years ago to represent the actions of transformers, the angles he had chosen were such as would make the primary impedance increase on closing the secondary. Giving an expression connecting the primary currents on open and closed secondary respectively, he now showed that to get increased impedance the sum of the lag angles in primary and secondary must exceed 90°. To get large power in the secondary the primary lag should be nearly 90°, and the secondary about 45°. He also pointed out that some of the figures in the paper might be simplified considerably.

Prof. PERRY said he had long had the impression that if a sufficiently small current were taken from the secondary, increased impedance would be observable in all cases, and he quoted some numbers he had given in the *Phil. Mag.* for 1891, showing a decided increase.

Mr. RIMINGTON, in reply, said he was not aware that the effect he had now brought forward had been observed previously. The result was completely worked out analytically before using geometrical methods.

Another experiment on ELECTRIC RADIATION IN COPPER FILINGS, was similar to those described by Dr. Dawson Turner at the Edinburgh meetings of the British Association.

A battery, galvanometer and glass tube containing copper filings were joined in series. Under ordinary circumstances no current passed, but immediately an electric spark was produced by an electric machine many feet away, the galvanometer was violently deflected, and remained so until the tube was tapped. On trying different materials, aluminium and copper seemed about equal, but iron not so good; carbon allowed the current to pass always.

Prof. MINCHIN said the phenomena were strikingly like those exhibited by his "impulsion cells," for the moment a spark passed, even at a distance of 130 feet they became sensitive to light. Very minute sparks were capable of producing the change, but, by adding capacity to the sparking circuit the effect could be greatly modified.

Replying to a question from Mr. RIMINGTON, he said the change was due to electro-magnetic vibrations, and not to light emitted by the sparks.

Mr. BLAKESLEY enquired if lengthening the sparks produced greater effect on the copper filings.

Mr. LUCAS asked if the resistance of a tube ever became infinite again if left for a long time.

In reply, Mr. CROFT said the current sometimes passed before the spark actually occurred between the knobs. He had not left tubes for very long, and had not found the resistance re-appear without tapping.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION.*

(*Continued from page* 488)

THIRD DAY.—September 14th.

MORNING SESSION.

(*Discussion of yesterday concluded.*)

H. NEWMAN LAWRENCE, Esq., M.I.E.E., of London, England, sent a contribution to the discussion, entitled, IN MEDICAL INDUCTION COILS, HOW DOES THE CURRENT OF THE PRIMARY DIFFER FROM THAT OF THE SECONDARY; AND WHAT INFLUENCE HAS THIS DIFFERENCE UPON THE RESPECTIVE PHYSIOLOGICAL EFFECTS?

The charging current can be measured both as to voltage and ampèrage; the secondary current is the source of alternating impulses, and dependent for voltage and ampèrage upon the number of turns around the primary, the strength of the charging current, and the rate of interruption of the vibrator. Muscular contraction may be produced by an infinitesimal ampèrage, provided it be sufficiently concentrated. In general, therefore, when muscular contraction is required, the primary current is the more painful to use; but owing to its other properties it may be found in certain cases less painful when applied to the nerves.

The discussion was continued by the reading of a communication from Dr. WILLIAM F. HUTCHINSON, of Providence, R.I., entitled, A STUDY OF ELECTRICAL-ANÆSTHESIA AND FREQUENCY OF INDUCTION VIBRATION.

This paper was supplementary to one on the same subject read at the last meeting of the Association. By means of Cook's reed-pipe, the author had been able to more accurately determine the number of vibrations. He now believed that the cause of electrical-anæsthesia must be looked for in that principle of mechanics known as the superposition of small motions. In a vibrating wire it is found that there is a "dead point" or spot at which the wire is at rest. Replacing the reflected wave on the wire by an efferent impulse along the nerve, we can imagine that electrical-anæsthesia is due to the formation of a similar "dead point" along the nerve. Just as many vibrations must be imparted to a sensory nerve inwardly as are proceeding outwardly upon it in order that a dead point or zone of anæsthesia be created. The rate of the electric wave and that of the nerve impulse seem to be identical, and hence pain is the mechanical expression of disturbed energy, and it is to be destroyed temporarily by such vibratory action as will restore rest to the nerve. The writer admits, however, his inability to explain why it is that the anæsthesia should be confined to an area not much greater than the electrode, although it is easy to demonstrate that the current traverses the whole length of a nerve.

The PRESIDENT here took part in the discussion, making some remarks ON THE INFLUENCE OF FREQUENCY AND THE GRAPHIC CURVE ON THE RESULTS OF GYNÆCOLOGICAL ELECTRO-THERAPEUTICS, PARTICULARLY WITH THE SINUSOIDAL CURRENT.

His conclusions were based upon observations made with the faradic current and an apparatus constructed for him by the Kidder Manufacturing Company, consisting of an alternator run by a motor, by which an alternating current, having 800 alternations per second, could be sent through the primary coil of his induction apparatus. With five Leclanché cells in the primary, the current obtained in this manner and with this, this number of alternations was almost imperceptible to the hand, but he noted that it was appreciable in the vagina. It had a marked soothing effect on the patients upon whom he had tested it. He claimed to be able to cure endometritis with the alternating current or the interrupted induced current as obtained from the improved faradic apparatus he had devised. The way in which it accomplished this was, in his opinion, by its influence upon the vaso-motor supply in relieving pelvic congestion which is often the primary cause of the trouble. Where the canal is not patulous, free drainage was secured by occasional negative galvanic applications of very moderate strength.

He believed with Mr. Bland Sutton, that in the great majority of cases of salpingitis the obstruction in the tube is due to tumefaction of the mucous membrane, and if this can be removed, as is often possible, by means of a proper application of the current, it is an easy matter to secure natural drainage of the tubes through the uterine cavity.

One very noticeable effect of this current was a very decided improvement in the systemic condition, even when it was applied to the pelvic organs.

(The discussion was here interrupted to allow Dr. Kellogg and Dr. Morton to demonstrate the properties of the alternating current as obtained from their machines.)

Dr. A. LAPTHORN SMITH then resumed the discussion. He said that the same increase in weight which is observed after the application of the sinusoidal current results from ordinary exercise. Referring to the fineness of the interruptions, he said that an excellent vibrator for this purpose could be made out of a piece of ferrotype metal. He had been able to obtain with the fine wire faradic current all that Apostoli claimed for the sinusoidal current. The improve-

* Abstract of the proceedings of the third annual meeting held in Chicago, September 12th, 13th and 14th, 1893.

ment in the circulation was principally due to the muscular contractions produced by the current.

THE ALTERNATING CURRENT IN ELECTRO-THERAPEUTICS.

DRS. GEORGES GAUTIER and A. LARAT, of Paris, France, sent a paper with this title. It was translated and read in abstract by Dr. A. Lapthorn Smith.

The paper stated that the faradic current attained its maximum quite suddenly, whereas the sinusoidal current reaches its maximum much more gradually, and consequently a larger dose can be borne. They claimed that any current having oscillations not over 20,000 per minute is a sinusoidal current, and that the action of the sinusoidal current, even when muscular movements are absent, is to increase the absorption of oxygen and the elimination of carbonic acid and urea. One curious point noted was, that if after a person has eaten asparagus, he be subjected to the action of the sinusoidal current, the asparagus will not impart its peculiar odour to that person's urine. They claim that the current is useful in reducing obesity, and in treating certain forms of eczema and vitiligo, and that it is peculiarly efficient in the treatment of infantile and pseudo-hypertrophic paralysis. They recommend that the current be applied through electrodes hanging over the edge of a porcelain bath, and they add that for the sake of propriety it is desirable that the water of the bath should be rendered opaque by the addition of starch.

Dr. HERDMAN said he had had very little personal experience with the high frequency currents, but he had been using for the past three years the Thomson-Houston dynamo current, giving 10,000 alternations per minute. It was an agreeable current, but exerted a peculiar tonic effect on the vaso-motor system. We must admit that vibrations producing musical tones have some special physiological effects, but remarkable results are obtained with vibrations extending even beyond the limits of such tones.

Dr. GEORGE J. ENGLEMAN, of St. Louis, thought in this discussion the faradic current had been treated in a pitiable way. The objections which had been made against it were those which applied to the old-time instruments, and which he had overcome by his separate vibrator and interruptor. Determining the number of the vibrations by musical notes is not only time-consuming, but is necessarily inaccurate, on account of the large personal equation which it involves. He had gone still further with his investigations, and had shown that in addition to the improvements already mentioned, special coils must be constructed for certain definite effects. He had no experience with the sinusoidal current, but from what he had seen and heard from those who had introduced it, he had not been tempted to experiment with it.

Dr. MORTON, in closing the discussion, said that he thought the criticisms of the preceding speaker admitted the objections which had been made upon the unreliability and limited efficiency of the faradic coil as ordinarily constructed. He had been much puzzled by Dr. Hutchinson's paper; for if he understood it correctly, we were asked to assume that the vibrations of an electric current, which are given at 540 per second, interfere with the vibrations of a nerve impulse, which are about 11 to 19 per second. Although he admitted the power of the current to produce certain analgesic and subjective effects, he did not believe it could produce true anæsthesia, and he could not but deprecate the fact that at neither the last meeting nor the present one had Dr. Hutchinson demonstrated his method of producing electrical anæsthesia.

THE TREATMENT OF DYSMENORRHŒA BY THE GALVANIC CURRENT.

Dr. A. LAPTHORN SMITH, of Montreal, read a paper on this subject, in which he took the ground that dysmenorrhœa is very commonly due to endometritis, rather than to stenosis of the canal. Thus, many cases are not at all relieved by rapid dilatation of the canal, unless this procedure is followed by curetting or the application of iodine. From theoretical considerations he had been inclined to believe at first that the method of intrauterine galvanisation which he advocated for the relief of dysmenorrhœa, would result in sterility, but further experience has shown this not to be true. Apostoli quotes 30 cases in which pregnancy followed such applications. This important theoretical objection being disposed of, he felt free to urge the adoption of this treatment, as the mild currents employed rendered it both safe and painless. If the uterus be large, and the menstrual flow profuse, he would use the positive pole in the uterus; but if the uterus were poorly developed, and the flow scanty, then he would prefer negative pole.

After a careful bimanual examination has excluded pregnancy, and has enabled the operator to form a correct idea of the condition of the pelvic organs, the vagina should be disinfected with a douche, and a large Simpson sound, curved to correspond with that of the uterine canal, is passed through the flame of an alcohol lamp, cooled, and insulated with rubber tubing to within about 2½ inches of its tip. Under the guidance of the finger it is then gently passed into the canal until an obstruction is met with, when a current of about 10 m.a. is turned on. The instrument soon passes on, and after a current of from 20 to 50 m.a. has been allowed to flow for about five minutes, it is gradually reduced and turned off. The sound will then usually almost drop out of itself. A boroglyceride tampon is then inserted in the vagina, and the patient allowed to go home. No precautions, such as resting in bed, are considered necessary, and as a rule, the patient only received the treatment twice a week for from three to six weeks, when the second period will usually come on without pain. When the intra-uterine electrode is connected with the negative pole, the positive pole consists of a clay abdominal electrode. Where the positive pole is made the active one, this pole must be of platinum, carbon, or zinc.

DISCUSSION.

Dr. MASSEY said he could endorse all that the author had said about the simplicity and safety of this treatment. He rarely saw atresia except after the use of very strong currents, or where the operator had neglected to insulate the cervical portion of the electrode. For this purpose, he preferred shellac to a rubber tube.

Dr. W. B. SPRAGUE, of Detroit, said he had very rarely failed to relieve dysmenorrhœa by intra-uterine application of electricity. He preferred to use the negative pole with a current of moderate strength, and so far from producing atresia, he had relieved such as already existed. In this class of cases, he never used currents stronger than 15 m.a., and he was inclined to believe that the menstrual pain is due to hypersensitiveness of the nerves rather than to endometritis; for he had relieved the condition by currents so mild that they could hardly be expected to cure an endometritis.

Dr. P. S. HAYES, of Chicago, said he wished to be placed on record as fully endorsing the claims made in the paper.

Dr. MARGARET A. CLEAVES, of New York, said that after an experience of six or seven years, she could corroborate what had been said in the paper. She thought the dysmenorrhœa was quite as often due to pelvic congestion as to endometritis, and that this explained why it was relieved by such mild currents. A number of her patients had become pregnant within a few months, and she did not believe that intra-uterine galvanisation caused sterility after the treatment. She greatly preferred leaving an interval of from five to seven days between the treatments.

Dr. KELLOGG had found that although there was no stenosis of the canal, many cases of dysmenorrhœa are associated with vegetations, which he believes swell up at the menstrual period, and so produce a temporary obstruction. At any rate, such cases readily yield to applications of 10 to 20 m.a., usually with the positive pole in the uterus. Where the trouble seems to be due to simple hyperæsthesia, he had found the positive pole especially effective. His experience was entirely opposed to the idea that the treatment prevented pregnancy.

Dr. C. R. DICKSON believed with Dr. Cleaves that dysmenorrhœa is very frequently due to simple pelvic congestion. He was glad to see that operating surgeons were showing a greater disposition than formerly to refer these cases to those who make a specialty of electro-therapeutics.

Dr. FRANKLIN H. MARTIN sounded a note of warning against recommending such intra-uterine treatment too freely to the general profession. The initial step should be the making of an accurate diagnosis. If the dysmenorrhœa were due to non-development of the uterus, the faradic current of slow vibration would be much more appropriate than the galvanic; if, on the other hand, it were due to tubal or ovarian disease, the galvanic treatment would result disastrously. Where dysmenorrhœa is due to endometritis or stenosis of the canal, positive galvanisms to the interior of the body of the uterus only was indicated.

Dr. WALKER said that when the pain was most marked two or three days previous to the appearance of the flow, he was always very suspicious of the existence of disease of the appendages, and therefore would not resort to galvanic treatment until a careful examination under chloroform had excluded such a condition.

Dr. SMITH, in closing the discussion, said that he had taken it for granted that an accurate diagnosis was a pre-requisite to safe and successful treatment. Believing as he did that in the majority of cases dysmenorrhœa is due to reflex spasm of the fibres of the internal os, brought about by an endometritis, he preferred to apply a mild current *directly* to the internal os.

THIRD DAY.—September 14th.

AFTERNOON SESSION.

THE TREATMENT OF SUBINVOLUTION BY ELECTRICITY.

Dr. CHARLES G. CANNADAY, of Roanoke, Va., read a paper with this title. The author believed that the greatest benefit is to be obtained in the shortest time from the use of electricity. He recommended for restoring the tone of the uterus that a current of 30 m.a. be applied to the interior of the uterus for 10 minutes at a time, and that this be followed by the application of the faradic current from an Engleman coil of 600 metres, using a bipolar vaginal electrode. He thought the free use of ergot during labour predisposed to subinvolution, and, therefore, when this drug had been used in this way, he favoured as a routine measure, the daily application to the uterus of the faradic current.

DISCUSSION.

Dr. HAYES thought no agent superior to electricity for re-awakening the retrograde physiological process necessary to complete involution, but he preferred the galvanic to the faradic current. He more commonly employed the positive pole, as there is ordinarily a condition of undue moisture present.

Dr. SPRAGUE did not think it made much difference whether the galvanic or the faradic current was employed, but to obtain the best results, the applications should be made on alternate days.

Dr. MASSEY used the faradic current chiefly in cases which had not existed for more than six months; for the more chronic forms, he preferred galvanism. He believed subinvolution to be due to microbic infection of the uterus at the puerperal period, and if the infection be due to the gonorrhœal germ, the case will prove most obstinate to treatment.

Dr. SMITH also thought that septic infection was chiefly responsible for subinvolution. He corroborated what had been said about the value of the continuous current.

Dr. CANNADAY, in closing the discussion, said that where subinvolution had lasted for a year or more, the congestion had in large

measure subsided, and, therefore, greater benefit was likely to follow negative galvanisation.

A New Intra-Uterine Electrode.

Dr. PLYM. S. HAYES, of Chicago, exhibited an intra-uterine electrode, made of a platinum spiral, with a stilette in its centre. The object of this special construction was to furnish an instrument which would allow of the free escape from the uterus of the gas evolved during the Apostoli treatment. He had found that by attention to this detail in the treatment, much of the after pain could be avoided.

Discussion.

Dr. EUG. C. GEHRUNG, of St. Louis, said that when he first employed the Apostoli treatment by galvano-puncture, he found that the gas accumulated in the tumours, and formed the basis of future abscesses; so he had constructed an electrolytic trocar and canular, which was described and illustrated in Dr. Massey's book. It was found that the gas and fluids sometimes escaped from the tube for days after the treatment.

Dr. MASSEY said he had observed enormous quantities of gas escape from the canula, but he thought most of the irritation observed after the treatment was due to the use of inflexible instruments.

Dr. DICKSON thought that the tip of the instrument should be protected, and that any such spiral instrument was objectionable on account of the trauma likely to be produced during its introduction and withdrawal.

Dr. HAYES replied that there was not in reality so much difficulty in introducing and withdrawing the instrument as one would suppose who had not tried it. The evolution of gas is so great when strong currents are employed, that it prevents in a measure the adherence of the tissues to the electrode.

(To be continued.)

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

By Prof. W. CAWTHORNE UNWIN, F.R.S.

VI.

Distribution of Power by Gas and by Electricity.

Distribution of Gas for Power Purposes.—Gas distribution has one distinctive advantage over compressed air or electricity distribution, namely, that the manufacture is carried on continuously through the 24 hours, the fluctuations of demand being met by storage, which is neither difficult nor expensive.

There is no reason to think that the cost of ordinary lighting gas is so high as to preclude its use on a considerable scale for power purposes. Taking the cost of lighting gas at 2s. to 3s. per 1,000 cubic feet, and the consumption of a gas engine, on an ordinarily varying load, at 26½ cubic feet per hour per horse-power, the cost of the power for gas, exclusive of interest on the gas engine, comes to £8 to £12 per horse-power per year of 3,000 working hours.

But the cost at which lighting gas is sold includes interest on a vast network of mains and the loss due to leakage over an extensive area. This part of the cost is not fairly chargeable against gas used for power purposes. In an installation for power the system of mains would be far simpler than in a distribution for lighting. With a comparatively few consumers taking comparatively large quantities of gas at a steady rate throughout the year, all the interest and depreciation charges would be smaller than those incurred in a distribution of lighting gas to a multitude of comparatively small consumers. It appears that the cost of the manufacture of coal gas, including coal, wages, and petty stores, is about 10d. per 1,000 cubic feet. Probably 18d. per 1,000 cubic feet would allow sufficient margin for profit and cost of distribution to power consumers in a manufacturing quarter not unfavourably distant from the generating works. But at that cost per 1,000 cubic feet, the cost of the power would be only £6 per effective horse-power per annum. The charge for interest and depreciation on the motor plant and for wages would not add to this more than £3, making the total cost to the consumer £9 per effective horse-power per annum.

Central Electric Lighting Station at Dessau.—This station, where the motive power is produced from gas engines worked with lighting gas, has been sufficiently successful to show that such a method of obtaining power is commercially possible. The motor installation consists of two 2-cylinder (Otto system) gas engines of 60 horse-power each; one single cylinder engine of 30 horse-power; and one of 8 horse-power. The group of engines work to about 160 effective horse-power. Directly coupled to these are dynamos of corresponding power. The 8 horse-power engine is used for day work and for starting the larger engines. The jacket water is cooled by air coolers, and used over again. There are 1,076 square feet of cooling surface. An injector, worked by pressure water from the town mains, circulates air through the coolers. The water consumption is thus reduced to 5 gallons per horse-power hour for all purposes.

In an electric station, gas engines have the advantage that they can be started and stopped when required, and have no stand-by losses like those of steam-boilers. At Dessau, a large accumulator battery is used for storing energy when the engines supply in excess of the demand, and restoring it in hours of small demand. The efficiency of the battery on the average of the year is 79 per cent. About 52 per cent. of the whole supply passes through the battery, so that the waste of current due to the battery is about 11 per cent. of the total yearly supply.

The average gas consumption of the motors is 26½ cubic feet per effective horse-power hour. Motors of varying power were adopted with an idea that they would best meet a varying demand. The constructors of the station now think that the accumulator battery renders this unnecessary, and that motors of a larger and uniform size would be more economical. They claim, as advantages of a gas plant compared with a steam plant, that less space and less water is required; that there is absence of smoke and danger of explosion; and that gas stations can be distributed more easily over the area to be supplied.

Other Gas Supplies for Heating and Power.—A cheaper gas than lighting gas can be manufactured for heating and power purposes. 1. So-called "water gas," obtained by injecting superheated steam through incandescent anthracite or gas coke. Such gas has a volume of about 26 cubic feet to the pound, and develops about 7,373 thermal units F. per pound. 2. Dowson gas, made by passing air and steam through incandescent coal or coke. This gas contains a large amount of nitrogen, with the hydrogen and oxide of carbon. Four volumes of it are about equal in calorific value to a volume of lighting gas. It develops 160 thermal units per cubic foot. With anthracite at 13s. a ton, Dowson gas costs about 2d. per 1,000 cubic feet, exclusive of interest and depreciation on plant. 3. Mr. Thwaite has proposed for power purposes a gas of about 12 candle-power, obtained by mixing lighting gas and producer gas. Such gas can be manufactured for 4d. per 1,000 cubic feet, and could be distributed and sold profitably for 16d. per 1,000 cubic feet. Its calorific value is little lower than that of lighting gas.

The following shows the power that can be transmitted by means of gas to a distance of 5,000 feet.

A.—Lighting Gas.

Diameter of main in inches.	Initial velocity feet per second.	Initial absolute pressure lbs. per sq. inch.	Difference of pressure producing flow. Inches of water.	Quantity of gas. Cubic feet per hour.	Horse-power transmitted.
6	45	15·59	24·6	31,800	1,200
12	—	15·12	14·4	127,200	4,190
24	—	14·0	5·5	509,000	19,210
36	—	14·84	3·9	1,145,000	43,200

B.—Dowson Gas.

Diameter of main in inches.	Initial velocity feet per second.	Initial absolute pressure lbs. per sq. inch.	Difference of pressure producing flow. Inches of water.	Quantity of gas. Cubic feet per hour.	Horse-power transmitted.
6	45	16·70	55·4	31,800	353
12	—	15·64	26·0	127,000	1,413
24	—	15·15	12·4	509,000	5,655
36	—	15·00	8·3	1,145,000	12,722

Electrical Transmission of Power.

No doubt electrical transmission of power to great distances is possible by more than one method. It is a condition in such a case that a very high tension, 20,000 to 40,000 volts or more, should be used, or the cost is excessive. That such currents will be used seems likely, but can hardly yet be reckoned as accomplished, at least, on a large scale, and with commercial success.

In a great deal that has been said about the electrical distribution of power, one thing has been forgotten. It is, that there have always been means of transmitting power to considerable distances; and if such transmissions are rare, it is not because they would fail mechanically, but because the cost of transmission is too great for profitable application of the power. Motive power was transmitted four miles by compressed air in 1861, before electric transmission was thought of. If electrical transmission is to play an important part, it will only be when it can be carried out so cheaply that the power can be supplied to consumers at a cheaper rate than they can manufacture it for themselves.

In the distribution of electrical energy from central stations for lighting purposes, a great deal has already been accomplished. Financially electric lighting operations appear also to be succeeding, though it is too early to estimate the measure of their success. But a higher price will be paid for energy for lighting than for energy required for power. In towns like Geneva, where electricity can be generated by cheap water-power, and where gas costs 7s. per 1,000 cubic feet, the success of electric lighting is assured. In other cases the great convenience of the electric light will no doubt counterbalance some excess of cost when compared with other means of lighting.

In one other case, which is strictly a case of power distribution from a central station, electrical engineers have achieved a remarkable success. In the United States there are now some 4,000 or 5,000

* Abstract of Howard Lecture delivered before the Society of Arts.

miles of electric tramways, which are working with complete mechanical success. It does not appear that the cost of electric traction is much lower than the cost of horse traction. For one of the oldest and best managed tramways, the West End Street Railway of Boston, the working cost of traction has been given at 22 cents per car mile for electrical traction, and 24 cents per car-mile for horse traction, the earnings per car-mile being about the same in both cases. But the electric cars attain speeds of 10 to 15 miles an hour, and in American towns, with wide-spreading suburbs, they have great advantages. Almost with no exception—probably the Buda Pesth tramways are the only important exception—the electric tramways which are in successful operation have cheap overhead conductors, carried on posts. Such a system is not suitable for European towns, and with more expensive methods of carrying the conductors, the success of electrical traction is at least more doubtful.

A case where electricity is likely to be used very successfully in transmitting motive power is in working traffic on underground and overhead railways. When passenger trains have to be run at short intervals on a line with numerous stations, electric motors distributed over many carriage axles have great advantages, besides freedom from smoke and steam. It is possible that, even in working cost, the electric motor will be superior to the steam locomotive. But this, again, is a case where cost of power is not a governing consideration, or where, at least, a considerable price can be paid for power.

For both lighting purposes and traction purposes a high price can be paid for power. But when power is distributed for industrial purposes, the question of cost is much more important, and the progress of electrical methods of distribution has been much less rapid. Every electric lighting company would be glad to supply power, if only to increase the day load, and so to reduce the idle time of the machines, and in a very few cases power is taken from electric lighting mains. Mr. Shoolbred has stated that in Bradford a few electric motors for hoists, lathes, and other purposes have been fixed. But at 6d. a unit the cost per effective horse-power is £60 per annum (3,000 hours). At that rate the power can hardly be used except for occasionally worked or intermittent machines. Even if electricity were sold for power purposes at half the price charged for lighting, the cost of the power would be greater than that of steam or gas power.

Very probably, in future, alternating currents will replace continuous currents for distant transmissions. It has been decided to use alternating currents, simple or of two phases, for the transmission from Niagara to Buffalo. Alternating current dynamos are free from some of the insulation difficulties which have to be encountered in continuous current machines, and can be worked probably at tensions impossible for continuous current machines. If motors for alternating currents can be made simple and self-starting, like continuous current motors, then the facility of transforming the voltage of the current in a purely statical transformer is an advantage which will give alternating currents a superiority in long distance transmissions. But here again the cost of transformers is a not unimportant factor in determining the feasibility of a transmission. Probably it is only where water-power is available, and in most cases only where cheap overhead transmission is possible that electricity can be supplied at a cost permitting it to compete with other sources of power.

Electric Distributing Mains.—It is fair to point out that when the cheapness of electrical transmission is put forward as a reason for adopting it in preference to other methods of transmission, it is almost always assumed that such rough and cheap expedients as an overhead conductor on telegraph posts can be adopted. To a mechanical engineer such arrangements do not appear to afford adequate security or permanence for an important power distribution. In proportion as the number of consumers taking power from a common source becomes greater, the inconvenience and damage resulting from any stoppage of the supply of power becomes more serious. Hence it will probably prove to be necessary, if any general system of power distribution by electricity is carried out, to place the conductors in subways where they are protected from injury. Such a construction however will necessarily increase the cost of electrical transmission.

It is a special inconvenience of any mechanical system of transmission that no part can be disengaged from the transmission without the use of more or less costly and cumbrous appliances; and hence, practically, when all the machines are not running, a good deal of the transmission is kept running uselessly. Hence, the waste of work which the transmission occasions, when running at full load, is largely increased when only a part of the tools require to be driven.

Mechanical systems do not easily lend themselves to extensions of the works. Either they must be made of excessive size at first, or, when an extension is necessary, they must be removed and replaced by a new transmission.

The electric system, then, has these advantages: (1) Simplicity in the transmission between the engine and secondary motors by conductors instead of by shafting and gearing; (2) saving of loss in running an intermediate system of transmission constantly, whether much or little work was being done; (3) greatest efficiency of transmission, even with full load; (4) facility for effecting future extensions with the smallest modification of existing plant.

It has always been a question, where steam-power only is used, whether it is desirable to concentrate it in a single engine, or to work with each principal line of shafting driven by a separate engine. In dockyards, distribution of power by pressure-water or compressed air has long been practised, from precisely the same motives as those which influenced the engineers at Hersthal. In some large works gas engines, distributed at various parts of the works, are being adopted to replace the single steam engine and complex intermediate transmissions previously in use. At Seraing, for 20 years, there has been a distribution of power by compressed air, working motors on individual machines. At Birmingham, in several factories, air motors, involving as little trouble as electric motors, were used to drive small divisions of the machinery, and a large amount of shafting previously in use was removed.

Electric Transmission for Mining Work in Nevada.—An interesting case of the transmission of power electrically is that at the Comstock mines, Nevada. There existed at the mines a 10-foot Pelton wheel driven by water supplied under a head of 460 feet and furnishing 200 horse-power. To obtain additional power the water from this wheel is conducted by two iron pipes down the vertical shaft and incline of the Chollar mine to the Sutro tunnel level. It is there delivered at a pressure of 680 lbs. per square inch, equivalent to 1,630 feet of head, to six 40-inch Pelton wheels. The jet to each wheel is only $\frac{5}{8}$th-inch in diameter, and each wheel develops 125 horse-power at 900 revolutions per minute. Each Pelton wheel is coupled to a Brush dynamo, generating current, which is led to the surface, where it drives by dynamo-motors a sixty stamp mill. The Brush motors revolve at 850 revolutions per minute. Of 700 horse-power developed by the Pelton wheels, 435 horse-power, or 60 per cent., is said to be delivered at the motors. The Pelton wheels weigh only 1·8 lbs. per electric horse-power.

The Genoa Installation.—Exceptional circumstances have made it possible at Genoa to establish an electric supply in connection with a water supply. Some ten or twelve years ago works for supplying water to Genoa, additional to others then in operation, were constructed. The water is obtained from streams on the Piedmont Liguria frontier, and two large impounding reservoirs have been constructed on the Gorzente river, an affluent of the Po. The reservoirs are 2,050 feet above Genoa, there being a large surplus fall not required as head for the water supply. To relieve the pipes of unnecessary pressure, three relieving or service reservoirs were constructed, reducing to about 600 feet the pressure available for the transmission of the water to Genoa. The first reservoir is near the outlet of a tunnel by which the water is carried through a mountain ridge, and is 360 feet below the tunnel. At that point 730 gross horse-power are utilisable. The second reservoir is 360 feet below the first, and there also 730 gross horse-power can be obtained. The third reservoir is 500 feet below the second, and there 1,000 gross horse-power can be obtained. The water supply scheme has not been entirely successful, and the engineer, M. Bruno, and the consulting engineer, M. Preve, were led to consider the utilisation of the surplus fall to generate electricity, to be transmitted for lighting and power purposes to Genoa, distant about 16 miles.

At the three points described, electric generating stations, named after the Italian electricians, Galvani, Volta, and Paccinotti, are now in operation.

A first installation of a turbine of 140 horse-power was made in 1889, at the Galvani station. This proved successful, and the further development of the stations was undertaken. The Volta station supplies electricity to 15 motors distributed along the valley from Isoverde to Genoa, and to a motor of 60 horse-power at the railway station in Genoa. It also supplies motor transformers at the Central Electric Lighting Station in Genoa. The remainder of the power at this station, amounting to 600 horse-power, is utilised by means of telodynamic transmission. The Volta station supplies electricity for lighting the station of Sempierdarena by a motor of 60 horse-power, driving 12 Siemens and two Technomasio dynamos, and also supplies electricity for motive power to a number of mills and factories, and the repairing shops of the railway. Messrs. Cuenod, Sautter & Co., of Geneva, who constructed the electrical plant, have furnished the following details. Messrs. Rieter Bros., of Winterthur, constructed the first turbines erected. The remainder have been constructed by Messrs. Fæsch & Piccard, of Geneva.

Electrical System.—The distribution is in series at constant current. The generating dynamos maintain a current of constant intensity in a single circuit which traverses all the motors. They supply a constant number of ampères whatever the number of motors at work. The voltage is essentially variable. At certain hours all the motors are out of action. Then the dynamos furnish a current at 450 or 500 volts corresponding to the loss in the circuit. At certain hours both the motors supplying power and the motors driving dynamos for lighting are in action. Then the voltage reaches 5,000 to 6,000 volts.

Galvani Station.—This has a single group of machines, consisting of two Thury continous current dynamos, coupled by Raffard couplings to a Rieter turbine of 140 horse-power, having a normal speed of 450 revolutions per minute. In addition, a jute factory absorbs the power of two Rieter turbines of 300 horse-power, the power being transmitted to it by telodynamic cables. The generators have six poles, and give at full load 47 ampères at 1,000 to 1,100 volts. Their speed varies from 20 to 475 revolutions per minute according to the demand for power. The dynamos are coupled in series and work day and night.

Volta Station.—This has been in operation since 1891. There are four turbines of 140 horse-power each, and eight dynamos working at 47 ampères and 1,000 volts at full load. These generators work at constant speed, and the regulation is effected by varying the exciting current. The regulation is effected by a single regulator however many generators are in action. The main turbines are Fæsch and Piccard turbines with relay governors, which maintain a strictly constant speed.

The regulation of the exciting current involves difficulties, because the voltage of the main circuit must vary from moment to moment, and sometimes quite suddenly, when motors driven by the current are thrown out of action. The motors are thrown out instantly by short circuiting them. To meet these conditions, the exciting dynamo is driven by a separate 15 horse-power turbine, which has as little inertia as possible. The exciting dynamo has a very light armature, so that it follows instantly the variations of speed of the turbine driving it. The exciting dynamo is itself excited by a small machine serving to light the station, and the stability of its magnetic field is thus independently secured. The turbine driving the exciting machine is provided with a relay governor, but the conical pendulum, ordinarily used to secure constant speed, is replaced by a solenoid holding in equilibrium a soft iron core weighing 33 lbs., which is

directly attached to the valve of the relay. A leather belt keeps this core and the valve in rotation, so as to practically annul any frictional effect. A spring and counterweight permit the adjustment of the action of the regulator. The solenoid is traversed by the current in the main circuit, which is normally 47 ampères. If the current augments, the core of the solenoid rises, puts in action the relay, and closes the sluices of the turbine driving the exciter. *Vice versâ* if the current decreases, the relay opens the turbine sluices.

This system Messrs. Cuenod & Sautter state has given good results. Nevertheless, at the third, or Paccinotti station, a return has been made to the system adopted in the Galvani station. The regulation is effected by varying the speed of the main turbines, which are constructed with as little inertia as possible, and have no speed regulators.

The Transmitting Arrangements.—The current is transmitted by bare copper wires, ⅜ths of an inch in diameter, carried overhead on poles, with porcelain and oil insulation. The greatest distance of transmission is 30 miles. The line has a resistance of about 500 volts, or an efficiency at full load of 90 per cent.

The Motors.—The motors are all Thury motors, and are from 5 to 60 horse-power. From 5 to 18 horse-power they are bi-polar. Their regulation is effected by shunting, more or less of the current, and they are all placed in series. Larger motors are multipolar, and these are regulated by displacing, more or less, the points at which the current enters and leaves the motor. This has the effect of reducing the magnetic field, by causing some of the convolutions to be traversed in a direction reverse to the normal. Each motor is governed by a relay, and has a fly-wheel. A lever and counterweight is provided to adjust the governor.

The ratio of the effective work at the motors to the effective work of the turbines is stated to be 72 per cent.

The Lauffen-Heilbron Transmission.—The single case known to the author of the use of alternating currents for motive power distribution is at Heilbron. The Lauffen generating dynamo runs at 4,000 ampères and 50 volts. The voltage is changed to 5,000 by a transformer for transmission to Heilbron, and then reduced to 1,500 for distribution. Part of the current is further reduced to 100 volts in a network for lighting. The charge for current for lighting is 9d. per kilowatt hour. Current used for motors for industrial purposes is charged at 4d. per kilowatt hour, or about £42 per effective horse-power year of 3,000 working hours. This is for current alone, exclusive of interest on the cost of motors. In November last there were on the system 11 motors, aggregating 32 horse-power, a rather insignificant motive power distribution. So far as the author has had opportunity of judging, the three-phase system, with double transformation, is an expensive method of distribution. It is worth noting that Mr. C. E. L. Brown, who designed the Lauffen dynamo, speaks doubtfully as to the system. He says that one object of the Lauffen-Frankfort experiment was to show the advantages of the three-phase system for power distribution. But that it actually showed the disadvantages of the system, viz., complication in line, generator, and transformers.

NEW PATENTS—1893.

19,884. "Improvements in electric indicators or annunciators." M. BINSWANGER. Dated October 23rd.

19,921. "Improvements in time apparatus for automatically switching gas and electric lights." H. Y. DICKINSON. Dated October 23rd.

19,934. "Improved electricity meter for continuous and alternating currents." C. D. ABEL. (Communicated by the Compagnie Anonyme Continentale pour la fabrication des compteurs à gaz et autres appareils, France.) Dated October 23rd.

19,967. "Improvements in secondary electric batteries." W. PETSCHEL. Dated October 23rd. (*Complete.*)

19,989. "Improvements in the mode of and means for operating electric bells." J. J. HUSSELBEE. Dated October 24th.

20,011. "Improvements in electric lamp-holders and switches." G. BINSWANGER. Dated October 24th.

20,023. "Improvements in the method of heating, welding, or working metals electrically, and in apparatus therefor." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated October 24th. (*Complete.*)

20,046. "Electric selecting devices." S. S. BOGART and ELECTRIC SELECTOR AND SIGNAL COMPANY. Dated October 24th. (*Complete.*)

20,047. "Improvements in electrical apparatus for controlling semaphore and other signals." M. B. LEONARD and ELECTRIC SELECTOR AND SIGNAL COMPANY. Dated October 24th. (*Complete.*)

20,069. "Improvements in apparatus for controlling the application or use of electric currents of high tension and great quantity." R. LUNDELL and E. H. JOHNSON. Dated October 24th. (*Complete.*)

20,116. "Improvements in electrolytic cells." L. MOND and R. L. MOND. Dated October 25th.

20,155. "Improvements in or relating to electric bell ringing." G. G. TURNER. Dated October 26th.

20,191. "Improvements in electric stop motion drawing frames for fibrous materials." E. TWEEDALE, S. TWEEDALE, and J. SMALLEY. Dated October 26th.

20,226. "An improved electric clock." G. HERVIEU. Dated October 26th.

20,229. "Improvements in electric arc lamps." A. J. BOULT. (Communicated by La Société Mailhabuau and Fritsch, France.) Dated October 26th.

20,231. "Improvements in electric clocks and electric meters." F. PANTER and G. HILL. Dated October 26th.

20,325. "Improvements in the manufacture of electric pushes, pulls, and switches." W. R. WEBB. Dated October 27th.

20,381. "Improvements in joints for electric light fittings." E. A. CLAREMONT. Dated October 28th.

20,384. "Improvements in electricity meters." G. HOOKHAM. Dated October 28th.

20,402. "Electrical station indicator for use in railway carriages or other public vehicles." H. DE GRAVE. Dated October 28th.

20,408. "An improvement in or applicable to ear-pieces for telephone receivers." J. W. KINNIBURGH. Dated October 28th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

1,041. "Improved means of generating electricity for buildings." S. J. ROLLASON. Dated January 19th. Fixed on the buildings is an apparatus with sails, having a vertical spindle made to revolve by the sails attached thereto. Half of the apparatus is shielded (regulated by the wind) to stop back resistance, thereby bringing the whole force of the wind on the exposed portion of the sails. There is fixed to the spindle a wheel which is geared to drive a dynamo or machine at any speed required. 5 claims.

4,025. "An improved means of effecting electrical communication through the medium of a clock, or similar apparatus." W. H. MILLER. Dated March 1st. Relates to the employment of an ordinary clock, or other similar apparatus, to close electrical circuits in combination with a specially arranged index board, or dial, so that signals or communications may be given by the clock. 4 claims.

5,579. "Improvements in the manufacture of incandescent electric lamps." J. SWINBURNE. Dated March 22nd. For sealing cheap metals into lamps the inventor uses a special enamel which dissolves the oxide formed on the surface of the metals. 8 claims.

5,712. "Improvements in and connected with telephones." G. L. ANDERS and W. KOTTGEN. Dated March 23rd. According to the present invention it is proposed to incorporate with the carbon prior to placing the same in the retort, wire mesh or perforated sheet metal, into the interstices of which the carbon will enter and thereby be securely held. 2 claims.

5,931. "Improvements in the construction of multipolar dynamo-electric machines." W. L. SPENCE. Dated March 26th. The magnetising coils are wound so as to be of approximately equal diameter to the mean diameter of the armature, a casting in two or more parts, with the requisite number of poles, is then placed so as to surround the coil, more or less, on all sides, by this means an "ironclad" field is produced of very high efficiency and of comparatively light weight. 3 claims.

6,015. "Improvements connected with shades and shade or reflector holders for incandescent electric lamps." R. R. HARPER. Dated March 28th. Consists in a clip for encircling the lamp socket, or holder, said clip being adjustable and affixable in any desired position by a pinch screw. The face edge of the clip plate has a couple, or other number of headed studs for the shade or reflector to be suspended or otherwise held, said shade or reflector having a shank or fang with slot holes to fix it to the clip plate. 2 claims.

6,145. "An improved electric railway system." E. M. BOYNTON. Dated March 30th. The main object of the invention is to so suspend the car from the motor, that it is entirely independent of the same, permitting the latter to perform the slight undulations inseparable from running on any kind of road, without compelling the car to partake of same. 14 claims.

6,364. "Improvements in electric arc lamps." H. H. LAKE. (Communicated by H. Wilbrant, Brussels.) Dated April 1st. In this improved arc lamp the armature is pierced at its centre with a suitable hole for the passage of the carbon holder, and is adapted to oscillate upon a hinge, or the like, between the electro-magnet and a stop. A spring presses it at the same time against the carbon holder, which, consequently, cannot fall, and which, by reason of its weight, participates in the movement of the armature during the downward oscillation, but remains in its place during the upward oscillation. The oscillating movement of the armature is effected by the action of a spring, the tension of which may be regulated by a screw and an automatic interruptor. 1 claim.

6,637. "Improvements in electrodes for storage batteries." G. E. HEYL. Dated April 6th. Consists in employing compounds containing tungsten or chrome, with or without the addition of lead. 5 claims.

7,004. "Improvements in electrical cooking apparatus." A. WALLACE. Dated April 12th. In one form of the invention the inventor constructs an apparatus suitable for cooking chops, steaks or other similar articles of food, such as are usually cooked on a grill, and consisting of a chamber closed by a semi-circular cover, and of sufficient height and width to contain a revolving "spit" formed of radiating arms, secured on a spindle, upon which the chops, steaks or other articles are fixed, in single series, between the two sides and the apparatus closed. The side surfaces of the apparatus are traversed by the electric wires, and the current being switched on they become

rapidly heated, and the "spit," being slowly revolved, by hand or by mechanism, the chops, steaks, &c., are cooked on both sides at once. 2 claims.

7,142. "An improved method of renewing incandescent electric lamps." E. A. KRUGER. Dated April 13th. Consists in dividing the glass bulb in a plane lying at right angles to the long axis of the lamp. 1 claim.

7,466. "Improvements in electrical communication on railway trains." A. SHIELS. Dated April 20th. Has for its object to utilise the "Westinghouse" "vacuum" or other brake connections between the carriages, or the safety chains, in connection with the system. 2 claims.

7,569. "Improvements in apparatus for automatically operating electric lamp switches." P. EVERITT. Dated April 21st. The inventor uses a clock movement with adjustable cams operated thereby and adapted to operate a drum or its equivalent forming a switch provided with insulating pieces on its periphery; contact brushes are provided connected with the electric leading-in wires so that, as the drum is moved under the action of the cams to bring the brush against the uninsulated portion of the periphery, the circuit will be completed and the lamp will be lighted and so remain until the next movement of the cams partly rotates the drum so as to again bring the brush against the other insulated part of the drum and so on, the lamp being alternately lighted and extinguished at the times for which the cams are adjusted. 3 claims.

7,655. "Improvements in electrical call and indicating apparatus." G. R. NUNN. Dated April 22nd. Consists essentially of an instrument, or apparatus, constructed with two or more sets of electric transmitters or contact makers, such as switches or pushes, and a corresponding receiving and indicating board to indicate or record the movement of each of any two or more transmitters, or contact makers, whereby any predetermined order or message can be conveyed from the transmitter to the indicator board. 2 claims.

8,196. "Improvements in arc light poles or masts." B. DRAKIN and W. L. SPENCE. Dated April 30th. Relates to a combined lamp-post and ladder. The ladder part is a separate attachment which, when not in use, disappears completely within the body of the pole. The whole of the steps are controlled from one place preferably at the base, and are under lock and key, so that unauthorised persons cannot climb the column. The movement, also, can be connected with the switch lever so as to cut off the current when the lamp is climbable, thus preventing the possibility of accident. 4 claims.

8,212. "Improved means of holding and supporting electric conductors or other wires, ropes, or bars." M. H. SMITH and T. P. WILSON. Dated April 30th. According to this invention the conducting wire or wire to be supported is gripped in a suitable recess between two plates with internal and external projecting lugs, the latter when in position bearing against end lugs or fingers on a second or top or bridge plate. Resting in a suitable groove between the top of the lower plates and the bottom of the top or bridge plate is the cross supporting wire which may be suitably insulated. The bottom and top plates are secured together by bolts and nuts, the heads of the former finding a bearing beneath the internal lugs on the lower plates where they are held from turning by the sides of the gripping plates. When the nuts are screwed up, not only are the plates firmly held, but the wires are also tightly and effectively gripped. 5 claims.

8,258. "Improvements in carrying or supporting electric collectors." M. HOLROYD SMITH and T. P. WILSON. Dated May 2nd. Relates to the "fishing rod" type of support for a collector, and according to this invention it is proposed to hinge said rod to a pedestal or support to which is also pivoted a second but shorter rod, from the outer end of which to a predetermined point on the "fishing rod" extends a third pivoted bar, the two bars, the rod and the pedestal forming a parallelogram, beyond the side of which extends the "fishing rod." From the pedestal at a point more or less close to the pivot of the "fishing rod" is attached a spring, the other end being attached at about the pivot point of the two bars. 3 claims.

8,268. "Improved electrical steering gear." G. S. GRIMSTON and A. H. DYKES. Dated May 2nd. An electromotor situated centrally over the rudder head works by worm gear, the cross shaft which carries magnetic clutches and bevil wheels. The armature of this motor continually revolving in one direction, when the one clutch or the other is engaged, the rudder is caused to move to port or to starboard as the case may be. 3 claims.

8,556. "Improvements relating to alternating current electric machinery." O. PATIN. Dated May 5th. Relates to machines for alternating currents of high tension, which comprise one or more movable inductors and a fixed armature. 4 claims.

8,663. "Improvements in the cores of electro-magnets for motors and other purposes." H. F. JOEL. Dated May 7th. Consists in making the cores of electro-magnets for motors and other purposes of soft iron wire, or of thin iron ribbon, or tape. 5 claims.

8,854. "Improvements in fittings for electric lights." J. SMALLWOOD. Dated May 10th. A suitable insulating rod is provided which is fitted internally with two conductors which make contact with two contact clutches fastened to a suitable holder made of insulating material and provided with an adjustable collar which serves to keep the holder in position and ensures perfect contact between the conductors and contact clutches. The insulating rod is provided with a suitable single or double pole safety fuse. 3 claims.

8,956. "Improvements in or relating to electro-medical belts and appliances." A. KNOX. Dated May 11th. The electrodes which are usually circular discs are made with a domed shank or depression in their centre or otherwise in which are made two holes for the passage of the connecting wire. Holes are made in the material of which the belt is composed and the discs are placed on the belt so that the domed shanks project slightly through the material. The wire is then threaded through the shank from the back and passes out again at the back so that the wire not only connects the electrodes electrically but also fixes them securely in the backing of however light a texture the latter may be. 1 claim.

8,986. "Improvements in mains and conduits for electric cables, and in collars and connections for same." DAN RYLANDS. Dated May 12th. The inventor so constructs the mains for electric wires that there is glass only or some equally good or better non-conducting material for the electric cable to pass through. 3 claims.

9,132. "Improvements in heating and welding by electricity." H. HOWARD. Dated May 13th. All of the pencils are connected to one main, say the negative main, from the battery or other source of electricity, whilst the other main, say the positive main, is connected to the work, and in order to prevent any variation of the current used by one arc from affecting the steadiness of the other arc or arcs, the inventor interposes between each pencil and the main a suitable resistance. 1 claim.

9,147. "Improvements in or connected with electric fittings, such as fuse blocks, ceiling roses, switches, and the like." P. G. EBBUTT, and J. B. VERITY. Dated May 14th. The inventors provide a loose bar or block of china or other suitable non-conducting material made separate from the base of the fuse block, ceiling rose, switch or the like, this said bar or block being held entirely above, below or otherwise away from the base by the conducting wires which are fixed to the said loose bar or block by the terminal cramps and screws or by other means, or the said bar or block may be supported on a pillar or pillars rising from the base, or be carried upon independent blocks which rise from and are fixed to the base or to the wall or other suitable place. 7 claims.

9,486. "Improvements in switches and crossings for the trolley wires in the overhead system of electric traction." A. DICKINSON. Dated May 19th. The switch is formed with a movable tongue underneath which guides the trolley down below the wire on which it is travelling, and causes it to travel on a side or branch wire in any desired direction, and, when the trolley is coming in the direction in which the wires converge, opens when pushed by the trolley and allows it to travel uninterruptedly on the main wire. The movement of the movable tongue is controlled by means of springs so arranged as to hold it in its proper position and permit of an uninterrupted passage of the electric current. 5 claims.

9,758. "Improvements relating to the regulating of electric arc lamps. E. E. BEAUVALET and L. C. BEAUVALET. Dated May 23rd. The movement of the carbons is controlled by a balance lever or rocking beam having connected respectively one to each end, two armatures or cores controlled by two solenoids. Near this rocking beam is a pulley wheel preferably with ratchet teeth around its periphery for engagement of a spring pawl governed by the rocking beam and also with a plain surface on its periphery for the operation of a brake-block connected to the rocking beam. This apparatus governs the carbons by a cord or chain of any suitable kind attached at one end to the carrier of the upper carbon, passing over the aforesaid pulley, down through one of the side rods or otherwise under two pulleys on the carriage carrying the lower carbon, thence up the other side rod or otherwise to be attached to the rocking beam. The beam has an adjustable abutment for controlling the normal distance between the points of the carbons, and is provided with a spring, for holding it in the desired position when not acted on by either solenoid. The current when the circuit is closed passes through the one solenoid to the upper carbon, thence to the lower carbon (in contact) and thence from the lamp. The solenoid attracts its armature and rocks the beam causing the upper carbon to be raised by action of the pawl on the ratchet teeth of the pulley, and the lower carbon to fall by the rocking of the beam. The arc thus enters into action and the distance is controlled by the second solenoid, which is placed in shunt between the terminals of the lamp, operating on the armature attached to the opposite end of the beam. 5 claims.

9,941. "Improvements in electrical contacts." C. H. SMEETON and H. PAGE. Dated May 26th. The contact consists of an outer casing of iron or other metal containing two or more contacts fixed on an insulating plate embedded in the base of the case and on the face of the case is fixed another insulating plate containing two or more contacts, not in electrical contact with the contact plates, in the base of the case; on the face of the case are fixed two slides to carry the detachable part and to hold it firmly when in its place. The detachable part is a metal case having on the face an insulating plate, on which are placed two or more metal strips forming electrical contacts when in use. 5 claims.

11,526. "Improvements in electric cables." G. G. M. HARDINGHAM. (Communicated from the firm of Felten & Guilleaume, of Mülheim.) Dated June 20th. A twisted strip or core containing air spaces or channels is provided with a coating of lead, which may be applied by means of a lead press. Outside the lead, one coating or more of gutta-percha is, or are put on, by a gutta-percha covering machine; the lead coating preventing the gutta-percha in the soft state in which it is used in the covering machine from penetrating into the air spaces or channels. A serving of textile material, such as hemp yarn, is then applied. Over the serving of textile material is put a sheathing of interlocked wires, which form a flexible tube. 3 claims.

14,819. "Improvements in and relating to electric arc lamps." H. WATT. Dated August 16th. Consists in mounting the regulating coil or solenoid and the wheel train on the same base or frame so that when the upper carbon rod together with the wheel train is lifted for the purpose of striking the arc or separating the carbons the said regulating coil or solenoid which controls the brake is lifted at the same time.